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BUILDING THE STEAMSHIP.—III. WAR SHIPS

By Horace See, E. and N. A.

THE defenseless condition of England during the early part of the reign of King Alfred very much resembles that of our own country at the present time, the only difference being that we are at peace with all nations and consequently not suffering from the oppressive incursions of any foe. We are, however, more exposed to the attack of an enemy, having a sea-board so much greater in extent than that of England. The time required to land a hostile force upon our shores is not much longer (steam having annihilated distance and introduced some certainty into the movements of vessels) whilst the means at our disposal to intercept such a force and to destroy it before reaching our coast is not a particle better. Alfred believed that an ounce of prevention is of far more value than a pound of cure; that the best way to preserve the liberties of the people of England would be with a navy far more powerful than that of his restless persecutors, the Danes, and able to go out upon the open sea and successfully cope with them. He knew too well

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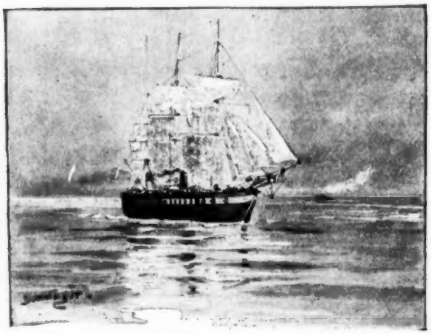


U. S. SLOOP OF WAR "HARTFORD."

that an island of the extent of Britain could not be defended by an army from a foe without, as the movements of the enemy and his point of attack were unknown quantities and impossible to meet.

As a wise king he exercised his sovereign right and created a navy according to his own idea of what was necessary to rid him of his persecutors. He selected the galley of the Mediterranean as the type best suited for his purpose, and made it twice as long, much deeper, much faster, and capable of carrying more fighting men than the vessels of the Danes. The result was that his fleets, by their superiority, destroyed those of his enemies and thereby conquered peace. He could now turn his attention to internal affairs, which he went assiduously about, laying the foundation and firmly establishing that system of government to which England is indebted for the benefits she now enjoys.

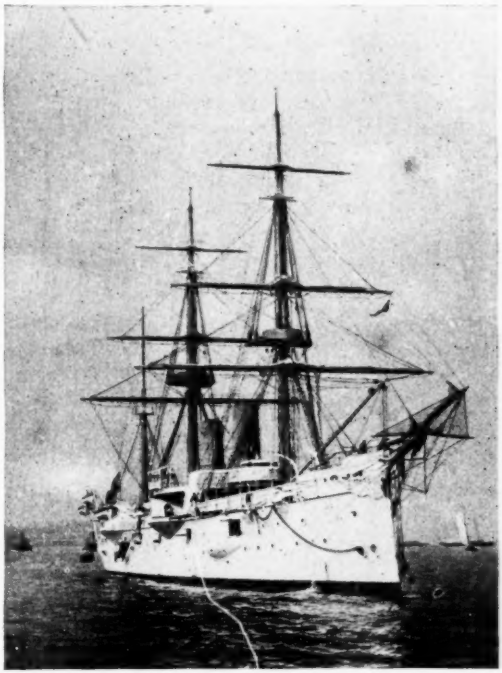
Our late strained relations with Italy have brought quite vividly to our notice how utterly helpless we would be in a war with a nation weaker than our own but having a much superior navy. Unfortunately the mass of our people, and I am afraid too many of our representatives, are unconscious of this helplessness and of the dangers to which we are exposed. A few of our public men, however, realizing our weakness, have endeavored to arouse some enthusiasm and create a navy capable, not only of sustaining the honor and dignity of the government, but also, of keeping our foes at a respectful distance in case of a sudden declaration of war.

That which is called our new navy was inaugurated whilst Mr. Chandler held the portfolio of Secretary. The four unarmored cruisers *Chicago*, *Boston*, *Atlanta* and *Dolphin* were contracted for in 1883. The speed of these vessels ranged from 15¼ to 15½ knots an hour—a fairly good showing when it is borne in mind that in 1882 but eight war vessels in the world under 5000 tons were able to steam 16 knots. The great advance, however, was made during

Mr. Whitney's term of office. Armored as well as unarmored cruisers were designed and the contracts given out for their construction. A definite policy for encouraging and domesticating the manufacture of armor and of forgings for high powered guns and heavy machinery was adopted. The triple expansion engine by which higher speeds and greater endurance have been secured was introduced.

The administration of Secretary Tracy has been conspicuous for bringing forward the triple screw commerce destroyer and heavier armored cruisers.

The old wooden vessels of our navy with their smooth-bore guns do not look quite so formidable as they did a few years ago when compared with the steel cruiser of to-day. The old frigate *Hartford*, for instance, with a displacement of 2900 tons, a speed of but nine knots and a battery of 12 nine-inch 4-ton, and eight-inch 3-ton smooth-bore guns, does not make much of a showing against the cruisers *Boston* and *Atlanta* of 3189 tons, having a speed of 15.58 knots and a battery of 2 eight-inch 11¾-ton, and 6 six-inch 5-ton breech-loading rifles.



THE CRUISER "CHICAGO," U. S. N.

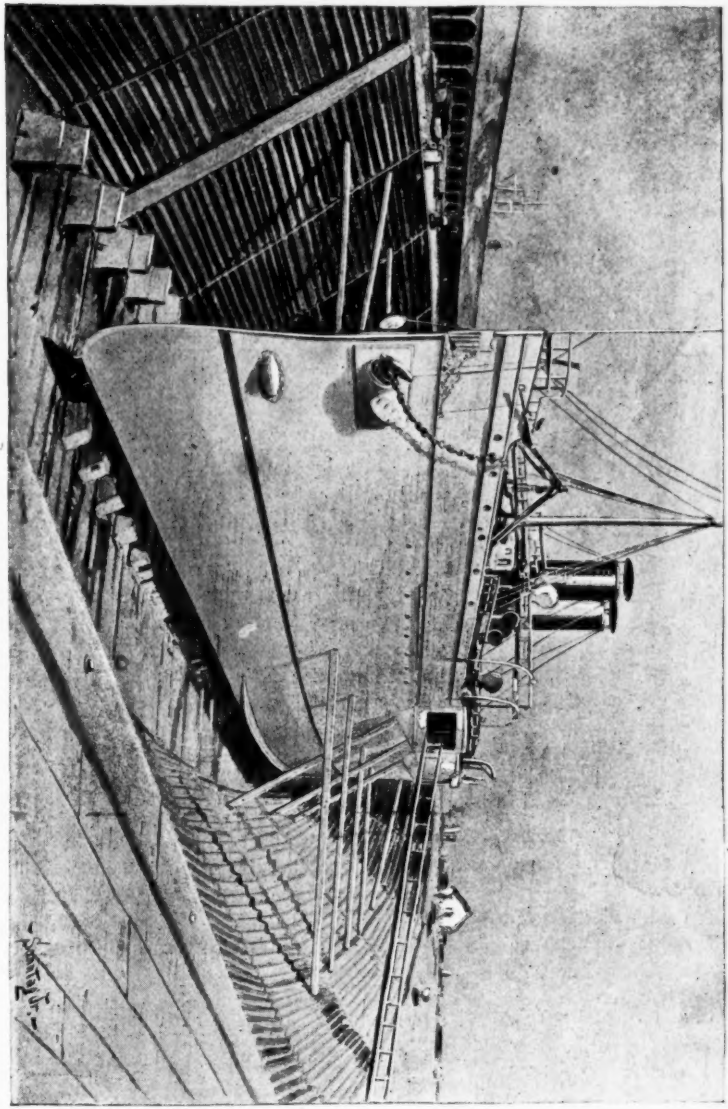
The steel hulls, the steel breech-loading rifles and the compound engine have been the factors in

this advance. The *Boston* and *Atlanta* were built by Mr. John Roach in 1884. They were fitted with back action compound engines driving a single screw. Contemporary with the *Boston* and *Atlanta* is the *Chicago*, built by Mr. Roach in 1885. She is a steel partial deck protected twin-screw cruiser of 4500 tons displacement, propelled by vertical working-beam compound engines of 5083 horse power at a speed of 15 knots. She has a coal capacity of 940 tons, which enables her to steam 0000 knots at ten knots speed. Her battery consists of 4 eight-inch, 6 six-inch, and 2 five-inch breech-loading rifles, 2 quick-firing and 10 machine guns, the heaviest battery in any of the cruisers of our navy now afloat.

The steel despatch vessel *Dolphin*, built by Mr. Roach in 1884, is of 1485 tons displacement. She is a single-screw vessel propelled by a vertical direct acting compound engine of 2260 horse power at a speed of 15.11 knots. Her battery consists of 1 six-inch 5-ton breech-loading rifle, 2 quick-firing and 4 machine guns.

In 1889, after the short interval of four years, a further advance is noted. The protection of the deck throughout has been introduced and the triple expansion engine for the first time applied to vessels of the U. S. Navy.

The first of these vessels built was the *Yorktown* or Gunboat No. 1. She is 230 feet long, 36 feet beam, with a displacement of 1700 tons at 14 feet mean draught. Her propelling machinery consists of horizontal triple expansion engines arranged in separate rooms with a water-tight door in the bulkhead between them. The engines drive twin screws and have cylinders 22, 31 and 50 inches diameter by 30 inches stroke of piston. The steam is distributed on all cylinders by piston valves actuated by the Marshall gear. The pistons are open hearth steel castings fitted with adjustable shoes on their bottom side to take the weight, and light sectional packing at the circumference to intercept the passage of the steam. This form of piston has given excellent results, and enabled the horizontal engine to perform in a very superior manner. The air and circulating pumps are worked by independent engines. The condenser is circular, independent of the framing of the engine, and made of brass. The framing of the main engines, although quite light, has withstood the work in a very satisfactory manner. The four boilers are of the Admiralty pattern, working in plenum in two separate fire rooms. They are $9\frac{3}{4}$ feet in diameter and $17\frac{3}{4}$ feet long. The gases pass into one common smoke-stack. Each boiler has its separate blower and feed pump. A bunker capacity of 400



THE UNITED STATES CRUISER "SAN FRANCISCO" IN DRY DOCK.

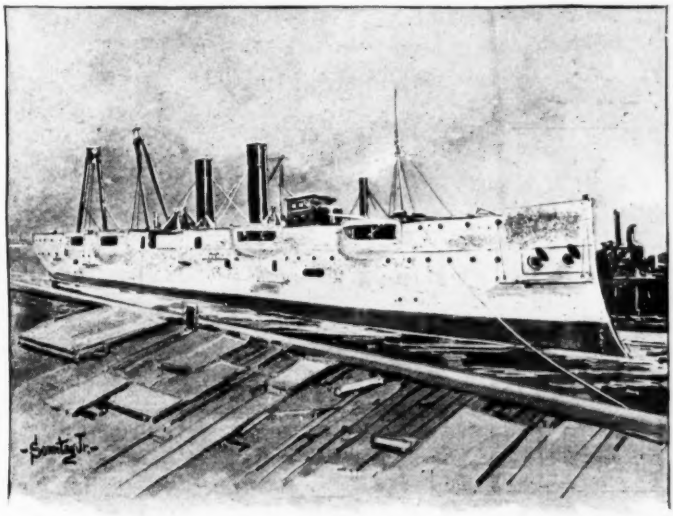
tons enables her to steam 9000 knots at ten knots speed. Her battery consists of 6 six-inch breech-loading rifles, 4 quick-firing and 5 machine guns. The speed of the vessel is 16.14 knots with 3394 horse power. She was built by Wm. Cramp and Sons in 1889. Steel of the open hearth variety enters almost exclusively into the construction of this vessel. Not only the plates but the beams and frames are made out of it. The reverse bars are incorporated and rolled with the frames into a Z-shape. The stem, stern-post and shaft hangers are open hearth steel castings. From this time steel enters largely into the construction of the hulls and machinery of the United States vessels.

Two more gunboats, the *Concord* and *Bennington*, similar to the *Yorktown* have been built by N. F. Palmer & Co., of New York. On their official trials they exceeded not only the contract requirements, but also the performance of the *Yorktown* on her official trial. The speed of the *Concord* was 16.8 knots with 3404 horse power, and the *Bennington* 17½ knots with 3436 horse power.

The *Charleston*, built in 1889 by the Union Iron Works of San Francisco, has become quite prominent in the chase of the *Itata*. She is 3 feet longer and about the same speed as the *Esmeralda*, which has been acting as convoy to the latter vessel. The *Charleston* carries 2 eight-inch and 6 six-inch breech-loading rifles, whereas the *Esmeralda* carries 2 ten-inch Armstrong breech-loading rifles. The *Charleston* having a larger battery, although the *Esmeralda's* guns are the heaviest. The *Esmeralda* is a protected cruiser and the first of that type built, preceding the *Baltimore*, *Newark*, *Philadelphia* and *San Francisco* of our own navy. The *Charleston*, also a protected cruiser, is 300 feet long, 46 feet beam, 18½ feet draught, and has a displacement of 3730 tons, against 3000 of the *Esmeralda*. She is propelled by twin screws, driven by a direct acting horizontal compound engine having cylinders 44 and 85 inches diameter by 36 inches stroke of piston and developing 6666 horse power. Steam is supplied by six Admiralty boilers 11 feet diameter by 19¼ feet long, working in plenum. The speed of the vessel on her official trial was 18⅓ knots. The battery of the *Charleston* consists of 4-quick firing and 9 machine guns in addition to those mentioned above.

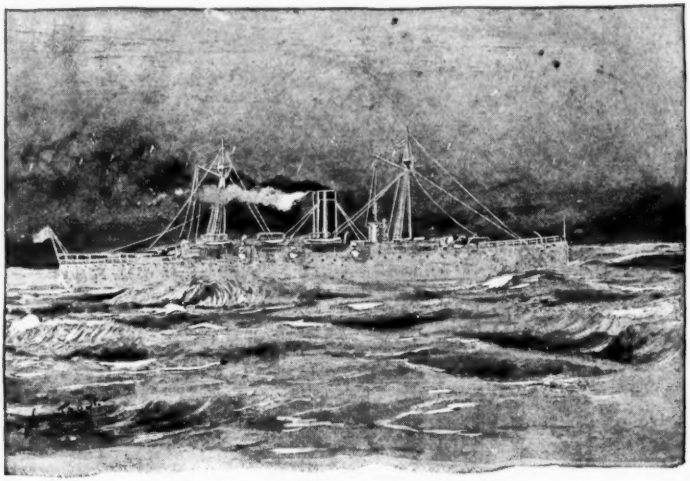
The first cruiser built in the United States with her deck protected throughout was the *Baltimore* of 4413 tons, 315 feet long, 48½ feet beam and 19½ feet draught. Her battery consists of 4 eight-inch and 6 six-inch breech-loading rifles, 6 quick-firing and

7 machine guns, and 5 fixed tubes for torpedoes. She is propelled by twin screws driven by direct acting triple expansion engines of 10,064 horse power at a speed of $20\frac{1}{10}$ knots. The engines have cylinders 42, 60 and 94 inches in diameter by 42 inches stroke of piston, supplied with steam from 4 double ended steel boilers $14\frac{1}{2}$ feet diameter by $17\frac{8}{12}$ feet long working in plenum. The engine framing is of open hearth steel made by the Standard Steel Casting Co., of Thurlow, Pa.,—the first application of steel in this country to such heavy and complicated castings. The *Baltimore* was built by Wm. Cramp & Sons, of Philadelphia, and completed in 1889. She can steam 12,000 knots at 10 knots speed.



THE UNITED STATES GUNBOAT "NEWARK."

The most distinguished of the fleet of vessels completed in 1889 is the dynamite gun cruiser *Vesuvius*, carrying 3 fifteen-inch pneumatic guns placed abreast and parallel at a fixed angle of 18°, the muzzles projecting through the deck at about 37 feet from the bow. Each gun is fitted with two revolvers, one for storage and one for firing. The vessel is propelled by twin screws and steered by steam. The training of the guns is done by steering the vessel and the range varied by the adjustment of the air valve controlled

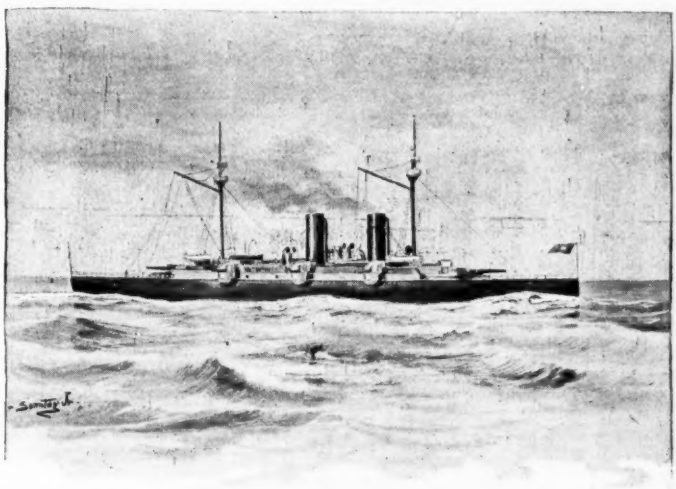


THE CRUISER "CHARLESTON," UNITED STATES NAVY.

in the conning tower on the deck immediately over them. The range guaranteed is one mile. Fifteen shells filled with 200 lbs. of explosives were to be fired in thirty minutes. The speed guaranteed was 20 knots. The performance of the gun and boat have been in excess of the contract. On the official trial of the guns, fifteen shells each 8 feet long with a capacity of 200 lbs. of explosives, were discharged without the slightest trouble in 16 minutes and 11 seconds, with an initial air pressure of 750 lbs. On the official trial of the vessel a mean speed of 21.65 knots was obtained from two runs on a measured course of 2.54 knots laid off outside the Delaware Breakwater. This took place on January 12, 1889, the engines developing 4366 horse power (mean) with a steam pressure of 160 lbs., and averaging 278.8 revolutions. The speed on the run with the wind and tide was 22.94 knots and on the return 20.34. The *Vesuvius* is 246 feet long, 26½ feet beam and had 810 tons displacement at 9 feet draught of water on the trial. The screws are driven by four cylinder vertical, direct acting, triple expansion engines having cylinders 21½, 31, 34 and 34 inches diameter by 20 inches stroke of piston. The cranks of the high and medium pressure are placed opposite to each other, as well as are those of the low pressure, and each set is placed at right angles to the other, making almost a perfect balance. The engine is the first

example of this kind built. All of the valves are of the piston variety, actuated by the Marshall gear. An air-pump is driven off of each low pressure crosshead. The steam is led to one surface condenser and the water circulated by one centrifugal pump. The four boilers are of the Admiralty pattern working in plenum, two being 9 feet and two 8¼ feet diameter and respectively 20 feet long. Each has its separate fire-room, blower and feed-pump. The gases are led into one common stack. Immediately forward of the engines are the two air compressors, one above the other, for supplying air to the guns. The air reservoirs are under the boilers and guns. One striking feature about the performance of the vessel has been that she succeeded with the first set of screw propellers made for her. It was not necessary to make a number of wheels to reach the contract speed.

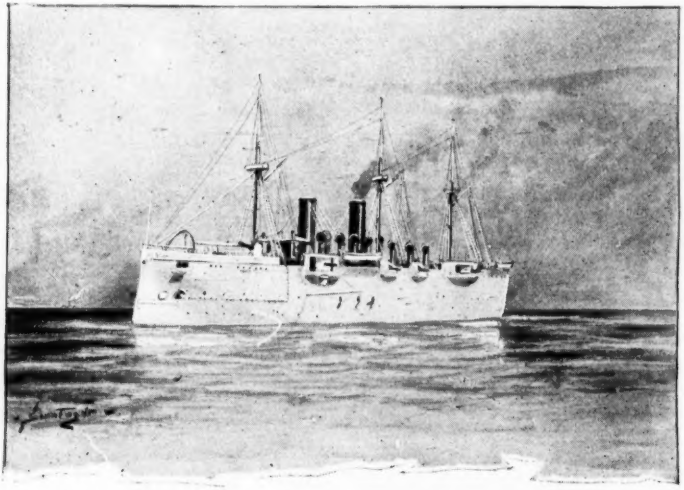
The smallest vessel built during Mr. Whitney's term of office is the *Petrel* or Gunboat No. 2. She is 175 ft. long, 31 feet beam and 890 tons displacement at 11 feet 7 inches draught. Her engines are of the compound back action variety, the last of their kind built for the navy. The speed attained was 11.55 knots. Her battery consists of 4 six-inch breech-loading rifles, 2 three-pounder quick-firing guns, and 5 machine guns, a much heavier battery than



THE ESMERALDA—CONSORT OF THE ITATA.

that of the *Dolphin*. The *Petrel* was built by the Columbian Iron Works of Baltimore.

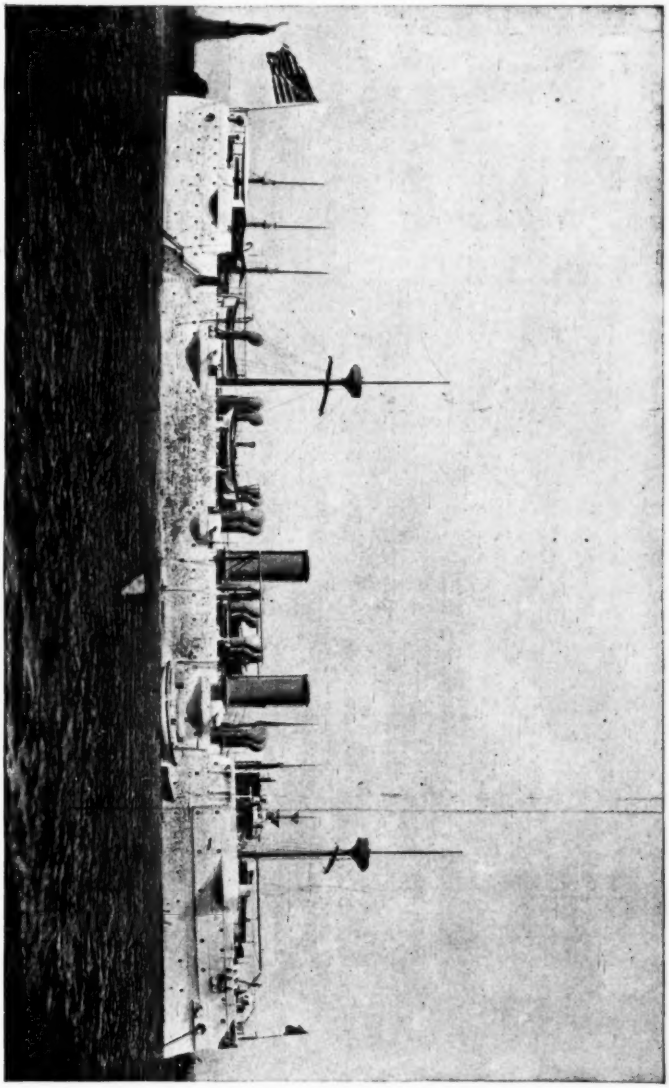
The cruiser *Philadelphia*, built by Cramp & Sons, is the same as the *Baltimore*, except in her rig and propelling machinery. The Baltimore has two military masts whilst the *Philadelphia* has three. The engines of the latter are of the horizontal, direct acting, triple expansion type, having cylinders 38, 58 and 86 inches diameter by 40 inches stroke of piston, steam being supplied by 4 double ended boilers 14 feet in diameter by 20 feet long working in plenum. The engines are capable of developing more horse power than those



THE UNITED STATES CRUISER "PHILADELPHIA."

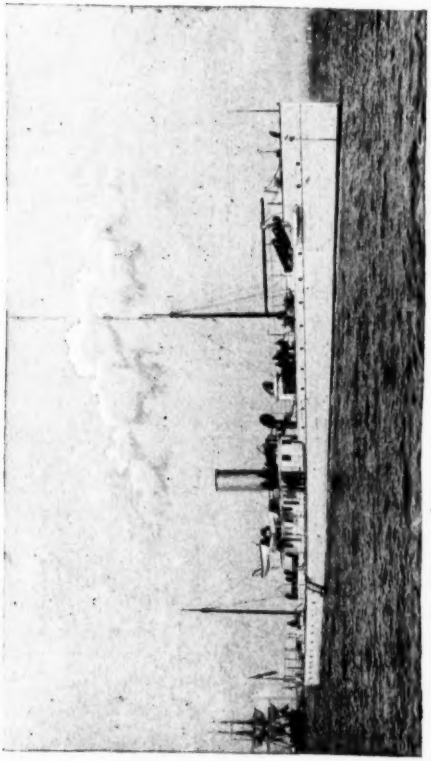
of the *Baltimore*, and driving the vessel at a higher speed than obtained on the trial. The result of the official trial was a speed of 19.678 knots with 8815 horse power. The weight of the machinery and water of the *Philadelphia* is 861 tons.

The Pacific Coast in this development has come forward to show what American skill and enterprise in that part of our country can accomplish. Following the excellent performance of the *Charleston* comes that of the *San Francisco*, a steel protected cruiser of 4083 tons. Her length is 310 feet, beam 49 feet 2 inches, draught 18¾ feet. Her battery is 12 six-inch breech loading rifles, 6 quick-firing, 7 machine guns and 6 fixed tubes for torpedoes. She has



THE CRUISER "BALTIMORE," UNITED STATES NAVY.—*From a photograph by J. S. Johnston, N. Y.*

twin screws, horizontal direct acting double expansion engines, cylinders, 42, 60 and 94 inches diameter—36 inches stroke, slide valves, Stephenson gear, 4 double ended boilers 14½ feet diameter and 19 feet long. Her speed on the official trial was 19.51 knots with 9913 horse-power.

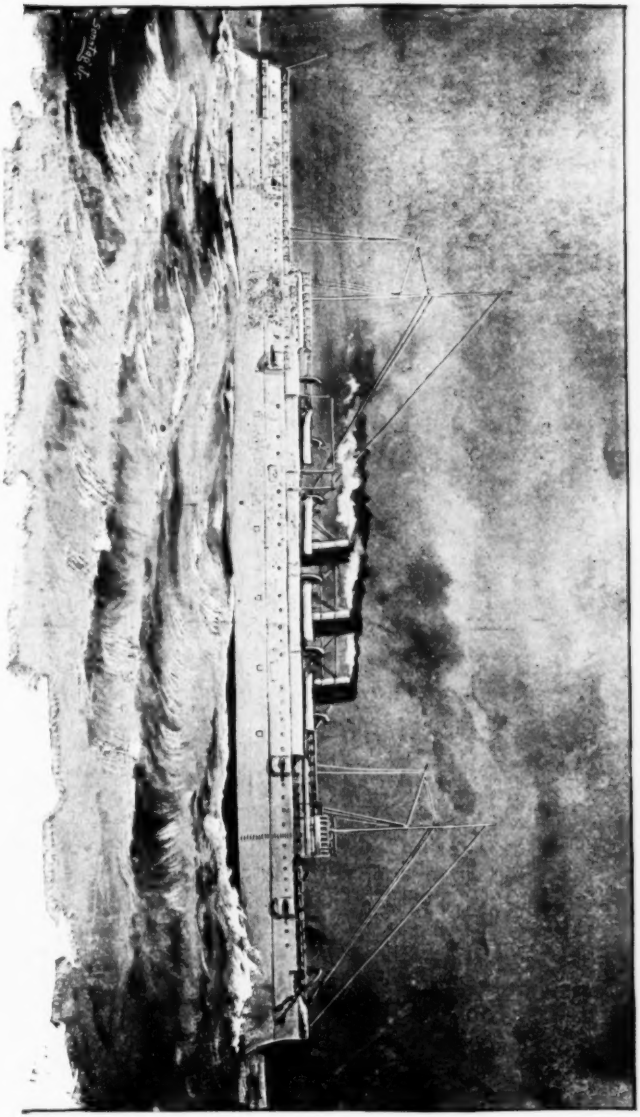


THE U. S. TORPEDO BOAT "VESUVIUS."—*From a photograph by J. S. Johnston, N. Y.*

The hull of the *Newark*, built by Cramp & Sons, is similar that of the *San Francisco*, but her machinery is different. The engines have cylinders, 34, 52 and 76 inches diameter by 40 inches stroke of piston, the slide valves being of the piston slide variety actuated by the Marshall gear. Four double ended boilers 13½ feet diameter by 19½ feet long working in plenum supply the steam. She can steam 10,500 knots at ten knots speed. She developed 8886 horse power and attained a speed of 19 knots on her official trial. Weight of machinery and water 746 tons.

One torpedo boat, the *Cushing*, (116 tons) has been completed and has attained a speed of 22.52 knots. She carries 3 one-pounder rapid firing guns and 3 torpedo tubes.

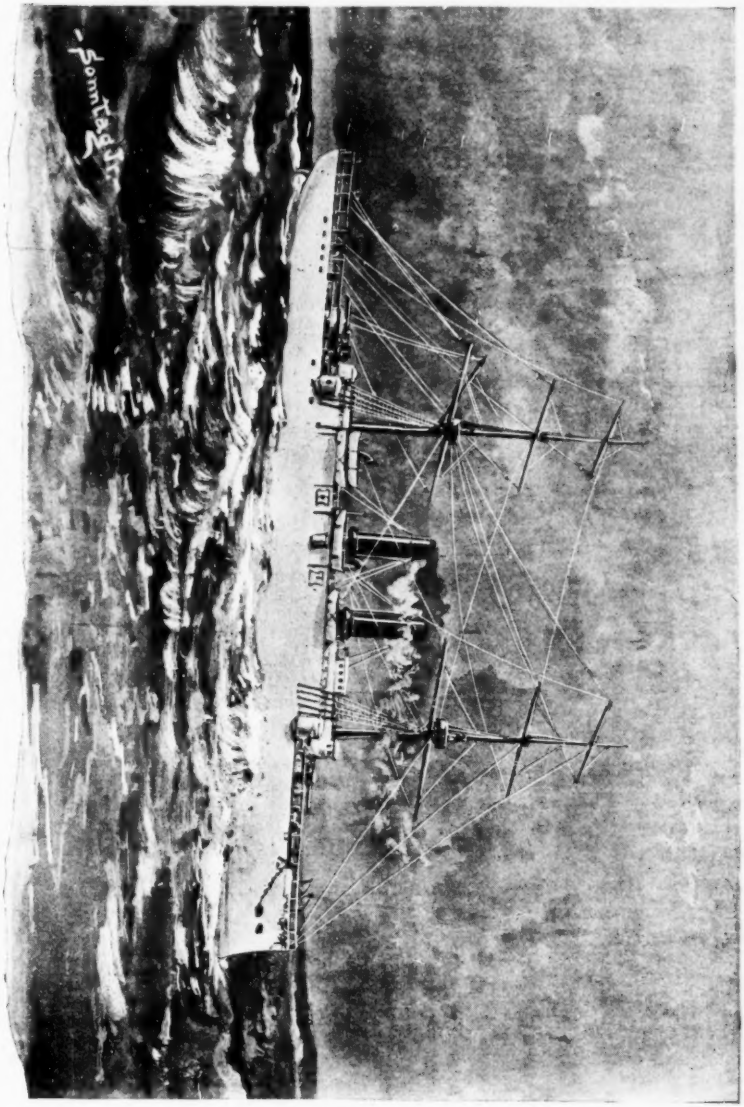
The number of vessels built or contracted for, including the double turreted monitors, is forty-one, as given in the following list :



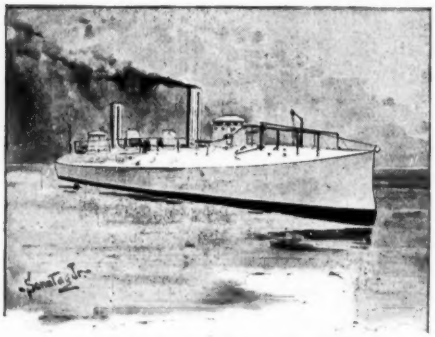
THE UNITED STATES PROTECTED CRUISER NO. 12, "PIRATE."

SHIPS OF THE NEW NAVY.

Vessel.	Description.	Displacement. Tons.	Where Built, etc.
ARMORED SHIPS.			
First Rate:			
1. New York	Cruiser	8,150	Bldg. Cramp & Sons, Phila.
2. Maine	Cruiser	6,648	Launched, N. Y. Navy Yard.
3. Texas	Battle-ship	6,314	Bldg. Norfolk Navy Yard.
4. Puritan	Monitor	6,060	Bldg. N. Y. Navy Yard.
5. Indiana	Battle-ship	10,298	Bldg. Cramp & Sons, Phila.
6. Massachusetts	Battle-ship	10,298	Bldg. Cramp & Sons, Phila.
7. Oregon	Battle-ship	10,298	Bldg. Union I. W., San Fran.
Second Rate:			
8. Monterey	Monitor	4,003	Bldg. Union I. W., San Fran.
9. Amphitrite	Monitor	3,815	Under com., Norfolk Navy Yd.
10. Miantonomoh	Monitor	3,815	Under com., N. Y Navy Yard.
11. Monadnock	Monitor	3,815	Under com., Mare Isl'd Navy Yd.
12. Terror	Monitor	3,815	Under com., N. Y. Navy Yard.
Third Rate:			
13. Harbor Defense Ram	Armored Ram	2,000	Bldg. Bath I. Works.
UNARMORED SHIPS.			
First Rate:			
14. Cruiser No. 6	Cruiser	5,500	Bldg. Union I. W., San Fran.
15. Cruiser No. 12	Cruiser	7,400	Bldg. Cramp & Sons, Phila.
16. Cruiser No. 13	Cruiser	7,400	Bids received June 1st.
Second Rate:			
17. Chicago	Protected Cruiser	4,500	In commission.
18. Baltimore	Protected Cruiser	4,413	In commission.
19. Philadelphia	Protected Cruiser	4,324	In commission.
20. Newark	Protected Cruiser	4,083	In commission.
21. San Francisco	Protected Cruiser	4,083	In commission.
22. Charleston	Protected Cruiser	3,730	In commission.
23. Boston	Cruiser	3,189	In commission.
24. Atlanta	Cruiser	3,189	In commission.
25. Cincinnati	Cruiser	3,000	Bldg. N. Y. Navy Yard.
26. Raleigh	Cruiser	3,000	Bldg. Norfolk Navy Yard.
Third Rate:			
27. Cruiser No. 9	Cruiser	2,000	Bldg. Columbian I. W., Bal.
28. Cruiser No. 10	Cruiser	2,000	Bldg. Columbian I. W., Bal.
29. Cruiser No. 11	Cruiser	2,000	Bldg. H. Loring, Boston.
30. Bennington	Gunboat	1,700	In commission.
31. Concord	Gunboat	1,700	In commission.
32. Yorktown	Gunboat	1,700	In commission.
33. Dolphin	Gunboat	1,485	In commission.
34. Gunboat No. 5	Gunboat	1,050	Bldg. Bath I. W., Bath, Me.
35. Gunboat No. 6	Gunboat	1,050	Bldg. Bath I. W., Bath, Me.
Fourth Rate:			
36. Vesuvius	Dynamite Gunboat	970	In commission.
37. Petrel	Gunboat	870	In commission.
38. Practice Ship	Gunboat	835	Bldg. S. L. Moore & S., Eliz., N. J.
39. Torpedo Cruiser	Gunboat	750	
40. Cushing	Torpedo Boat	100	In commission.
41. Torpedo Boat No. 2	Torpedo Boat	112	Bids received Dec. 20.



THE UNITED STATES STEEL CRUISER "ATLANTA."



THE U. S. TORPEDO BOAT "CUSHING."

England is building the turret ship *Hood* of 14,150 tons, and 17½ knots speed, and a number of barbette ships of the same size and speed. Italy has built the *Lepanto* of 13,550 tons, and 18⅜ knots speed and a number of others of the same size and speed.

The battle-ships *Indiana*, *Massachusetts* and *Oregon*, if anything are a little inferior to the European battle-ships like the *Hood*. Their armament is superior, but their speed is about 1¼ knots less. The breadth of the belt armor is 1 foot less. The coal supply is also 500 tons less. It is very important, in view of the fact that the United States is not as well supplied with coaling stations as England and the other powers, that our vessels should have a superior coal supply. Although the principal part of our fleet will be employed in home waters, an emergency may arise requiring them to cruise at some distance from their base of supply when it is all important to have a large bunker capacity.

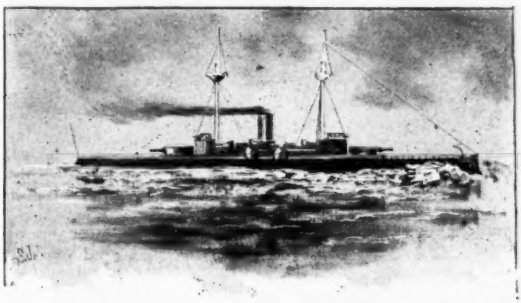
The most important vessel now building is Cruiser No. 12, known as the Commerce Destroyer and *Pirate*. It is expected to maintain a sea speed of 21 knots with her. Secretary Tracy thinks this "vessel absolutely without parallel among the warships of the world. The combination therein made unites a sufficient armament with complete protection against light guns, while at the same time the vessel will have a sea speed and coal endurance hitherto unknown in ships of war. No merchant vessel afloat that she meets, armed or unarmed, can escape from her." She has a coal capacity for 2000 tons and will carry 750 tons on her normal draught. She can steam 26,000 knots at 10 knots speed. Triple screws are to be employed and driven by separate engines capable of maintaining 20,000 horse power. Her length is 400 feet, beam 58 feet, and displacement 7400 at 23 feet mean draught of water. Her freeboard forward is 19½ feet. She will have a protective deck 2¼ inches thick on the flat and 4 inches on the slope. The battery will consist of 4 six-inch guns and 8 four-inch rapid firing, 18 machine

guns and 6 torpedo tubes. This vessel is intended to catch such vessels as the *City of Paris* with a length of 565 feet and a freeboard of 32 feet forward, and the *Majestic* of 582 feet. It is questionable whether she can do so in rough weather, as her short length and low freeboard is against her. Cruiser No. 12, on account of her light armament is only fit to engage with merchant vessels. It is therefore an open question, as she is an expensive vessel to keep in commission, whether it would not have been far better for the Government to have encouraged our merchants to build high speed ships that could be available in case of war, and capable to earn instead of spending money in time of peace.

The following dispatch that appeared in the press throughout our country on June 1st, shows how England believes her coast should be defended:

London, June 1.—England is rapidly developing an effective system of naval defense. Hereafter, every important sea port is to have what might be called a naval garrison. In accordance with recent regulations a warship is to be assigned to every port of consequence.

Such a system should be adopted here. In addition to this, there should be not less than three grand home squadrons, with one stationed on the Pacific and two on the Atlantic. These squadrons should be composed of battle-ships, protected and unprotected cruisers, gunboats, torpedo depot ships, torpedo catchers, torpedo boats, as well as special colliers for loading the squadron at sea. The strength of each squadron at all times should be maintained. When the repairs on any one of the vessels make it necessary to detach her, another vessel of the same class should be put in commission to take her place.



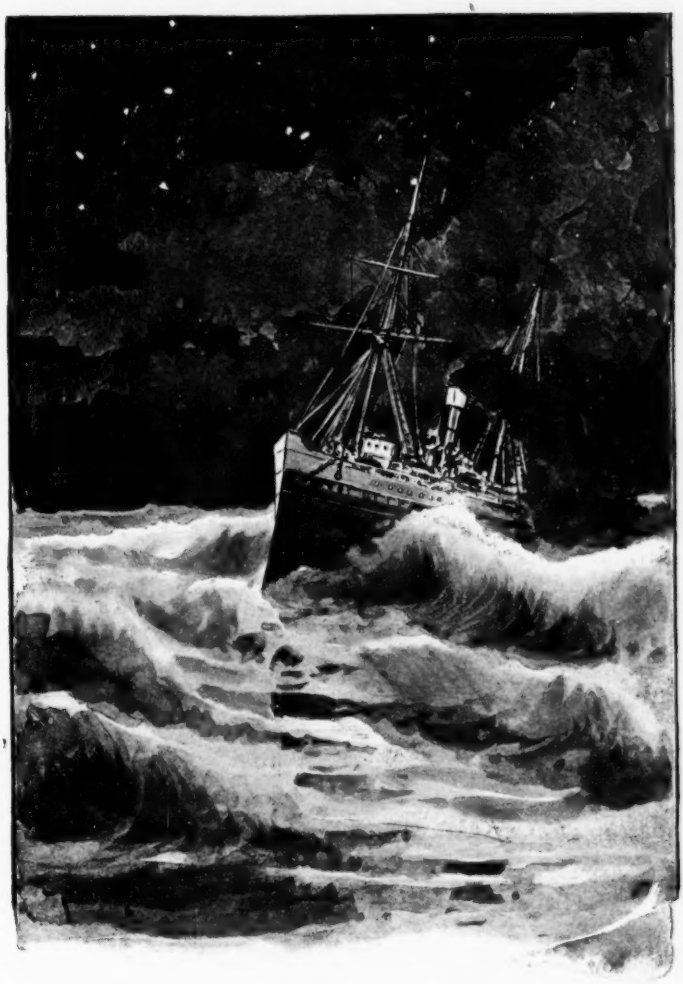
It was in the early part of the year 1886 that a notice appeared in a New York paper announcing that tenders would be received at the office of the Colonial Surveyor at Bermuda for the construction of a ship channel leading into St. Georges' harbor. It was stated that full particulars would be given by the Surveyor, Mr., or Sir Wellington Montague Marlborough Rae. I am not certain that I do this gentleman's Christian names justice; there were many of them, and they were so very English ; but I am *sure* of the "Rae."

A correspondence began by which I introduced myself and solicited charts, plans, profiles and specifications. I was informed that these things were at my disposal provided I survived a voyage to the Islands. So, with grip in hand, I mounted the gangplank of the good ship *Orinoco*, and bidding "My native land good night,"

> "The ship drove fast, loud roared the blast,
> And southward aye we fled."

The voyage to the Bermudas is, like a thunder-storm in August, brief but impressive. On the morning of the third day land appeared in a beautiful chain of green hills broken here and there by white-capped roofs, and surrounded by that rich ocean blue so peculiar to the tropics.

The Bermudas are coral reefs situated about latitude 32°, longitude 64° 50′. This is further from the equator than any other



"The ship drove fast, loud roared the blast,
And southward aye we fled."

point where living corals are known to exist. It is not generally noticed that these islands are about equally distant respectively from the north of Maine, the south of Florida, and the coast of North Carolina. This distance is about 700 miles. By far the greater part of the atoll is a submerged reef, elliptical in form, the greater axis extending about twenty-five, and the lesser about fifteen miles. The exposed portions constitute a chain of detached islands about twenty miles long and about six miles wide.

It soon became evident that we were in the midst of submerged coral reefs, whose dark and dismal figures were seen now to port, then to starboard, as the ship pursued her tortuous course toward the harbor at Hamilton. The coral clumps are from one to four fathoms under water, and are separated by intervals of deep channel.

> "Steep were the flanks, with precipices sharp,
> Descending to their base in ocean gloom,
> Safe for defense, but perilous to enter."

We landed at Hamilton. At the office of the Colonial Surveyor I was informed that Mr. Rae was expected at any moment. His courteous assistant, W. Cardy Hallett, an American, entertained me with marine charts of every age and description. About noon the Colonial Surveyor entered, and without even honoring me with a glance, proceeded, while standing, to look over the mail. I heard Mr. Hallett tell him of my visit and its purport. A good half-hour of silent waiting tested my patience to the limit, so, American like, I approached his majesty with extended hand, saying that though previously honored with his autograph, it now gave me great pleasure to meet him face to face, etc., etc. I told him why I came; I outlined my previous experience in submarine work; I gave him the names of my associates; touched upon some essential inquiries about the proposed channel, and tuned to a higher key by his blank silence, I hurled a big interrogation mark squarely at him and came to a full stop.

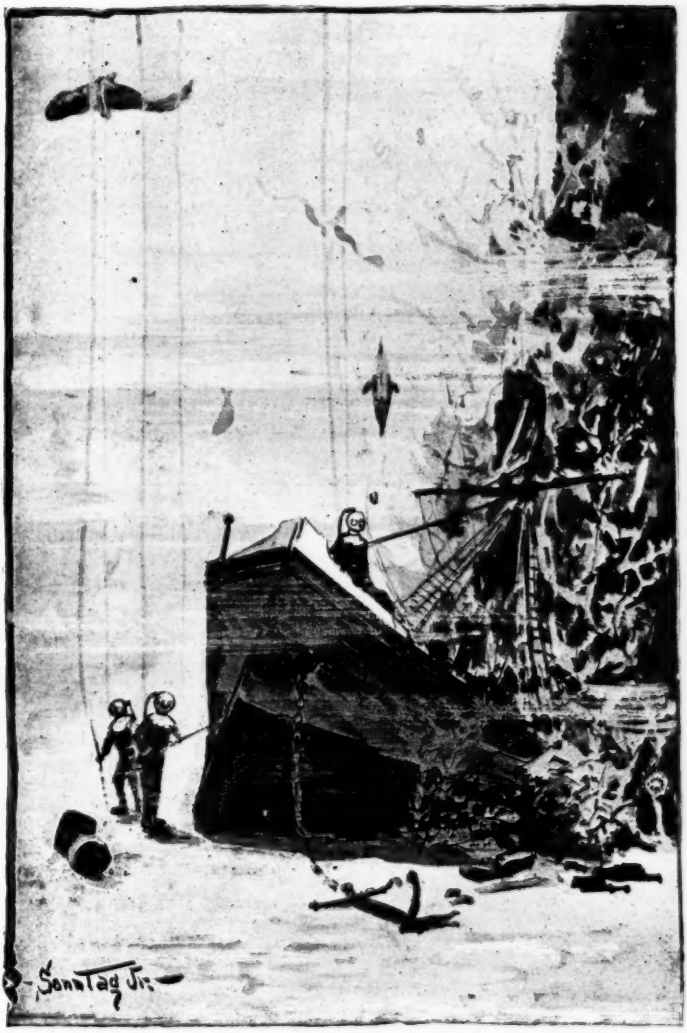
Gently raising his eyes towards me and toying with his mustache, he said:

"Well, er, Mr.—er—er—suppose you sit down and write me a letter saying that you are here."

"How's that, sir?"

"Er—er—yes."

Mr. Hallett came to the rescue by promptly showing me a seat. I grasped the extended pen and subsided into a blank study. What should I say?—



DIVERS AT WORK ON THE WRECK OF THE DARLINGTON.

"To his Royal Highness, the Colonial Surveyor of her Majesty's Islands, The Bermudas. I, an American engineer, having been invited by letter, etc., beg to say, also by letter, that I am here, in your presence."

Well, I wrote two full pages of formal matter and presented it. He read it twice, put it in his pocket, turned me over to Hallett, and went out.

"Mr. Hallett," said I, "who is that man?"

"The Colonial Surveyor."

"Is he sane?"

"O yes; that's his way. He's English, you know."

I departed from the office convinced of the following facts:

1. No survey had ever been made on the line of the proposed channel.

2. Mr. Rae was more of a society man and an army officer than an engineer, so that Mr. Hallett was left to attend to engineering matters.

3. It was really a matter of doubt whether or not the Colonial Surveyor could tell the difference between a theodolite and a thumb-screw.

My only course was to make my own examination. A drive of about twelve miles brought me to St. Georges. That drive, over the most perfect roads, clean and free from dust, now in the midst of cedars and palms, then so close by the sea that the spray covered us like rain, was the most delightful in my experience. Mark Twain said of Bermuda that the roads were so white and clean that it was hard to find a place to spit. That is so; but if Mark had seen our darkey driver he would have found a place. This fellow said it was his birthday, and he bemoaned his poverty that he must work on such a festal season. He won my sympathy and my purse. I afterwards learned that I had been entertained by a remarkable darkey who made it convenient to be born some two or three hundred times a year.

While excavating for a ship channel in New York Harbor I had met a Mr. Meyer, a prominent wrecker at St. Georges. I went to see him and was cordially welcomed. Boats, apparatus and man were placed at my disposal for the proposed survey, but the thing I wanted most, a diving suit, could not be had, as Mr. Meyer's three divers were actively engaged removing the cargo from the ship *Darlington*, which had recently split in two upon one of the outer coral reefs about fourteen miles away. Everybody advised

PREPARING FOR THE DESCENT.

that I ask the Government, through the Colonial Surveyor, for their diving apparatus. It was not in use and had been let before. Again I stood in the presence of Mr. Rae and pleaded my case. Again he told me to "sit down and write a letter." I made the request in the most humble terms my vocabulary afforded, giving assurances of my intention to pay liberally for the favor. I was told to await a reply by letter.

Back again to St. Georges, I began the survey with the aid of a water-glass. A brawny boatman rowed me over the line of the proposed channel, while I hung over the stern taking observations. A water-glass is a pyramidal shaped box, open at one end, with a water-tight glass head. It is like a bucket with a glass bottom. I held it over the stern of the boat, bottom down, and thrust my head in it.

"Through the waters clear and calm
I looked into the coral caves."

It seemed like a crystal palace. The water was as clear as air. I could see every reef, shell, fish or other object beneath the surface.

All the more eager was I to put on the suit and walk within the coral gardens.

But in vain I looked for the promised letter from Mr. Rae. Impatient at the delay, I attempted to get particulars as to the nature of the rock by following a pole held upon the reef by men in a boat. I plunged naked into the surf, drew myself to the bottom and there hung, eyes wide open, one hand on the pole and the other grasping a coral bush.

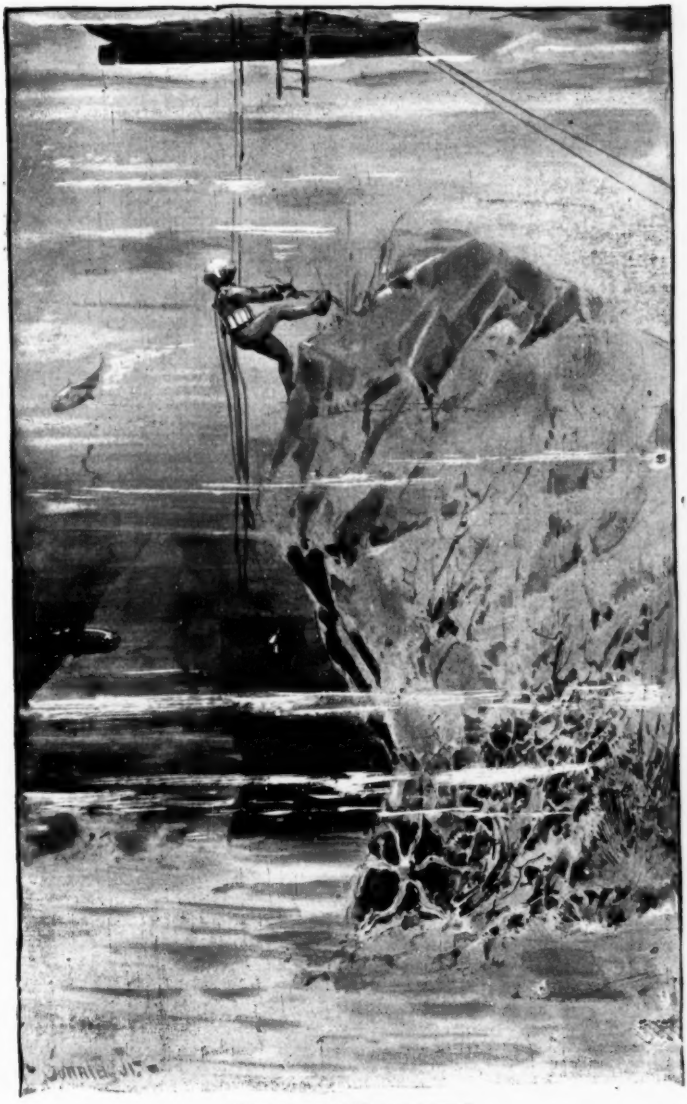
A member of the Colonial House of Assembly, while pleading for the passage of the bill to appropriate the money for this channel, gave the following remarkable account of my experience:

"Unable, sir, through the dilatory nature of our Government to procure a diving apparatus, this man put a pole upon the reefs, and clothed only in the garb of nature he went down the pole, walked about the bottom of the sea, and when he had completed the examination he ascended the pole to the boat."

My friend Meyer came to my relief. "I'll get you a diving suit," he said, "if it costs me a lawsuit. I'm under a time contract with the *Darlington* wreck, but I'll send the tug out at once and get my best apparatus and my best man."

It was a clear, calm day, but the surf rolled high. We anchored an open boat over one of the most formidable reefs, while Mr. Meyer's men proceeded to harness me in the suit. This was not my first experience as a diver, but this suit was a bad fit. It was made for a man double my weight, so that when in it, it seemed doubtful to the men that I was really *all* in. They gartered my calves with ropes that I might not tax the strength of one canvas leg by getting both feet into it. The rubber clasps to the sleeves were so loose at the wrists as to induce the remark from an old salt, that, so far from keeping the water out it was doubtful that they would keep the fish out. I was double-reefed at each sleeve, while a pair of stops served as wristlets. The shoes might have fitted Goliath, each weighed thirty pounds! When the helmet was in place I urged my attendants to start the pump and blow me up that justice might be done the tailor who made the suit. Over the ladder—the face glass on—the signal "all right"—and down I went.

The first sensation that a diver feels is one of sudden silence. He is shut out from the hum of life and hears only the labored pulsation of the pump. He knows this to be his breath of life. He next thinks of his ears, for as he sinks deeper the air pressure increases, and in its efforts to reach an equilibrium the drums of the



"Losing my hold I toppled over."

"I stood upon a bottom as white and clean as marble."

ears are momentarily strained. The relief is to swallow frequently.

I had previously marked the position of the boat so that I might in going down, reach the top of the rock, but the boat had drifted so far that I touched only the edge. This point was about fifteen feet from the surface of the water, and was an overhanging cliff with the bottom of the sea twenty-five feet below. In vain I tried to catch on; my left foot got entangled in a coral plant and, losing my hold, I toppled over, going down head first to the soft sand bottom forty feet under water.

A man who falls twenty-five feet head first doesn't usually think of his palate, but in this case I kept up a lively swallowing to relieve the sharp pains in my ears. Regaining my feet, I instinctively put my hand to my head to feel the lump, but soon realized that there was brass enough in the helmet to carry me through. I saw through the clear water a huge mass of honey-combed coral rock, covered throughout with living growth of every kind and description. Behind me and to the right and left was nothing but clear water. I stood upon a bottom as white and clean as a marble hall, rippled slightly by the wave motion of the sea. The rays of the noon-day sun shone through, clearly outlining the reef in a dark shadow upon the white sand.

"I felt the gay delirium of the scene;
I felt the breeze and billow chase each other,
Like bounding pulses in my human veins
For, though impassive to the elements,
The form I wore was exquisitely tuned
To Nature's sympathies."

What temple or monument made by the skill of man can compare with this sepulchre of "dead mummies of the builder worms."!

> "Compared with this amazing edifice,
> Raised by the weakest creatures in existence,
> What are the works of intellectual man?"

Through the water the reef looked a hundred times its natural size. I had provided myself with a hammer, and soon began to

STRANDED ON A CORAL REEF.

knock off specimens. Pausing a moment for rest, for the load I bore made light labor tiresome, I noticed a sort of crater in the rock directly under the overhanging cliff, and on a line with the sand bottom. The hole was about the size of my body. Getting down on my knees, I approached to ascertain the extent of the opening, for the thought struck me that here was an excellent place to insert a can of dynamite in the event of my being called upon to blow up the reef. When close to the hole, I saw what looked like a devil-fish in its den gazing intently at me. Making a move to get a little closer, I saw it gently draw itself into the hole. For a moment I was paralyzed with a chilling suspense. I was in no condition to fight a marine monster like this, who, with one grip of his tentacles around the air hose might shut out my breath of life.

Yet, seized with an irresistible impulse, and with hammer in one hand and cold chisel in the other, I plunged toward the object just as it appeared again at the mouth of the hole, and was revealed as a big piece of loose sea-weed that was drawn in and out by the swell of the sea.

I gave two pulls at the life line, the signal to haul up, and was soon standing on the ladder, with face-glass off, giving directions to heave a little to windward. Going down a second time, I stood on the reef and walked among the coral gardens. The living things of green and red and white and pink, stood up as plants stand up in air. It seemed as though a sudden flood had overtaken me as I walked in a conservatory of rare growth. There were the polyps of the Astræ tribe—so like the garden aster in form and delicacy of coloring; the star-like oculina; the lace-like branches of the towering madrepora.

Brain stones, some of them three feet in diameter, were scattered in my path. I stumbled over one of them, and paused to notice how like the head of a giant it was in shape and in its brain-like furrows. Scattered here and there in the midst of the honey-combed craters of the reef, were shells and marine things of kinds that I had never seen before. I remember the labor I spent trying to pull up a beautiful coral growth that looked like a miniature tree. It was no easy task to detach it, and when with the aid of hammer and chisel I broke its hold upon the cliff, it seemed to shrink and die. Its beauty was gone and I threw it in disgust away.

I could see every object clearly for at least fifty feet in every direction. Small fish would stand and watch me as though wondering at the intrusion. I wandered down a depressed part of the reef and was again upon the clear sand bottom.

> "The floor of ocean never trod by man
> Was visible to me as heaven's round roof,
> Which man hath never touch'd; the multitude
> Of living things, in that new hemisphere,
> Gleamed out of darkness, like the stars at midnight,
> —So to my view the deep disclosed its wonders."

Examination showed that this was not true sand, but fine particles of disintegrated coral, so light that as I walked the little specks were raised about me in a glittering dust. It reminded me of the atmosphere in Vermont at times when its moisture is frozen.

Approaching a dark object ahead, I discovered another coral clump covered with growth, almost identical with that I had examined. I concluded that the line of the proposed channel, which extended almost one mile from the harbor, was reefed here and there by these calcareous mounds of dead and living corals. Imagine all the buildings in a village thrown up and let fall where they may, and you will have a representation of the positions of the reefs in this channel. The water that embraced everything can be compared to nothing but itself.

I looked skyward to get my bearings from the position of the boat, and saw only the silver film of the surface that was undulated by the swell of the sea, only slightly perceptible at the depth where I stood. But the life-line and the hose were over my shoulder, and having finished my task, I signalled to pull me up. The attendants did not appreciate my reluctance to leave the scene, for I received a sharp "yank" that lifted me from my feet, and the next moment I was brought with a thump against the edge of the cliff. But with one bound I reached the surface, and lay upon the deck unburdened and transformed again to common life.

"'Twas a scene
That left itself forever on my mind!"

THE DEVELOPMENT OF THE SOUTH.

By Edward Atkinson.

THE deposits of iron ore and coal, and the timber of that part of the Appalachian chain which lies south of the Potomac and of the Ohio rivers, are mainly found in the States of West Virginia, in the southwesterly half of Virginia, in Eastern Kentucky, in Eastern Tennessee, in Western North Carolina and South Carolina, and in the northerly parts of Alabama and of Georgia. If we add to these portions of the several States named the westerly half of Pennsylvania and of Maryland and a small part of Ohio, a line drawn around the territory thus described would include the greater part of the coal, iron ore and timber of this section. It would also include what is known as the "blue-grass" section of Kentucky, the breeding place of our finest horses and cattle, the Cumberland plateau on the west of the mountains, and the Piedmont plateau on the east, the whole area being so much elevated above the level of the sea as to be in a true sense a white man's country. This mountain and plateau section possesses a climate in which any kind of work may be performed by white or black alike; in some portions of the area described are probably to be found the best conditions of climate, of soil, of humidity and rainfall, and of all the other elements which go to make stalwart men and women. To those who view natural scenery in its connection with the promise of homes for the multitudes who must be provided with them, there is nothing more beautiful or picturesque than the aspect of these mountains and valleys, which have been named "The Land of the Sky." The area thus described comprises about 250,000 square miles.

The chief sources of the iron production of Europe are to be found in Great Britain, Belgium, Luxembourg, France and Germany. The iron furnaces in each of these countries derive a part of their supply of fine ores from Spain and Sweden, as the iron works of our own country derive a part of their supply of fine ores from Wisconsin and Cuba, where there is no coal. If we combine the areas of England, Wales, Scotland and Belgium, a half of France and a half of Germany, we cover the main sources of the iron production of Europe within an area corresponding to that of this country, to wit, 250,000 square miles.

From these two sections of the earth's surface over 90 per cent. of the commercial product of iron of the world is now derived.

Our own product of iron, nearly one-half of the 90 per cent., is almost wholly consumed within our own limits, and yet does not suffice. We still import a moderate quantity in excess of our exports. Our consumption is now over 300 pounds per head. The iron-producing countries named in Europe consume within their own limits about 175 pounds per head. The remainder of their product is exported to all parts of the world, in which the consumption is now only 11 to 12 pounds per head.

Now, if one would attempt to forecast the future of that part of our own country which I have described, especially that Southland no longer unknown in the lower part of the Appalachian chain, he may draw the boundary lines upon the maps of North America and of Europe around the area of the iron and coal production, and then identify the centres of industry which have gathered near the sources of iron and steel and fuel supply in Europe. The great centres of varied industry may readily be identified which owe their position to their proximity to iron and coal, and which direct their occupation to the conversion of these minerals into their higher forms. Having thus identified the cities of Europe whose power is derived from coal and iron, one may mark upon the map of this country the places where cities corresponding to those of Europe must be established in the near future. I will not attempt to designate such places or to define them on our map, each reader must do that for himself; but let us pause for a moment in order to take into consideration the relative conditions of the old and of the new at the present time.

In making such comparison one must consider first the terrible obstructions to industrial and social progress by which almost all the states of Europe are oppressed, in spite of which the possession of coal and iron have given the states which have been named a relative position far in advance of other states which have not been endowed with such resources. If any one would fully comprehend the future industrial development of the area which I have bounded and described in this country, let him draw maps of each 250,000 square miles as I have described each section, on the same scale (of course eliminating the British Channel and North Sea), then set off London and Liverpool against our own great sea-board cities; lay one map on the other and stick a pin through the points over the European area where the great centres of industry are

now established; remove the map of Europe, and find the perforation in the map of our own territory; then imagine, if possible, what the conditions will be at or near those points a single generation hence. Are not the mountains of iron ore and the mines of coal, whether designated as "magnetic ore" or not, the true loadstones to which all forms of industrial energy are attracted?

At a few points the crystallization has begun, but as yet it is only a beginning, and one may not yet venture to predict where the processes will go on most rapidly. Even if the expectation of illimitable supplies of ore should not be realized, even if there is not a tenth part of what sanguine promoters have promised, the *coal* is there, and *coal* itself is *power*.

In a recent trip through Southwestern Virginia into West Virginia; through Eastern Kentucky and Tennessee into Alabama; then through Georgia and the Carolinas back to the point of beginning, we were welcomed everywhere and cared for among English speaking people. We passed over lines of railway which had been laid out only in the interests of peace and for the distribution of the abundance which makes for human welfare. We witnessed the fading away of the animosities engendered by the Civil War, and we witnessed the steady progress of black and white alike.

Something yet remains to be done in some of the States through which we passed to restore their public credit, without which their progress must be gravely retarded; but dealing with public debts on the average of the whole country, from which the general average of the specific area does not materially vary, it may be remarked that the aggregate of national, State and municipal debt has been reduced in ten years from $50 to $20 per head, of which only the lesser part is the debt still owing for war expenditures, all of which will be paid before the end of the century. In the whole tour we came upon but one military post, where four companies of troops were resting from their duties upon the borders. Had it been expedient to extend our tour to the source of the fine ores in the Gogebic range far away near Lake Superior, we should have met the same conditions everywhere. Contrast these with the conditions which one would meet in a corresponding tour through the iron and coal section of Europe.

Passing from Great Britain into France, from France through Belgium and Luxembourg to Germany, and taking into view the condition of Spain, would not one find every possible obstruction that could be placed in the way by difference of race, creed and

condition, by national animosity, accompanied by a burden of debt five times as great as that which now rests upon us?

On the route through Georgia we found four companies of soldiers camped at a sanitarium to rest from hardships of mere police service upon the border. In a tour of observation in Europe would not the soldier have been the most conspicuous element in the population everywhere? Does it not require the product of the work of one man occupied in the pursuits of peace to support every idle soldier in camp or barracks, waiting for the spark by which war and revolution may be engendered at any moment? Is not the border of each country an armed camp? Are not all the railways laid out more for the contingencies of war than for the service of peace? In a tour of observation in this country, do we not meet at every point new applications of science and invention to untouched or unexhausted resources, from which we are deriving higher wages in the conduct of the work accompanied by diminishing cost in the labor of production? In passing over the iron and coal areas of Europe, should we not find diminishing supplies of coal and iron ore? Are not low wages barely sustained at a rate which will scarcely secure a subsistence upon the continent of Europe, where every state is subject to an increasing cost and to increasing burdens either of armies or debts?

Again, one may put the question, must not Europe disarm or starve in the face of the coming competition of this country in supplying the great commerce of the world when we remove the obstructions which we ourselves have set up? So much for the vision which every one may indulge in who chooses to lay down the lines upon the map, and who may attempt to forecast the future of the section of this country of which I have given the boundaries.

The points on which assurance can be given even on a short trip are as follows: First, in respect to the railways; more solid, substantial and well-kept main lines cannot be found in this country anywhere than in a large part of the tract over which we passed. They are evenly and adequately balanced with broken stone, free from dust, and nearly all crowded with more traffic than can be handled on single tracks with their present equipment. It would take weeks of study to take in the broad and comprehensive plans of the managers of these great systems, the problem being entirely different from that which was presented in the connection of the Western prairies with the Eastern States and with the coast line. Southern lines were originally made for specific but limited objects, and were

intended to connect very few points each with the other. They have been gradually combined into great and comprehensive systems, starting from central points and diverging in all directions; the solid, substantial and wholesome growth of the city of Atlanta marking the result of the comprehensive plans which have governed one of the main systems.

With respect to the resources of the country, it needs only a trip of two weeks, or even less, to prove the existence of almost unlimited supplies of fire-clays, kaolin and glass sand, iron ore, coal, manganese and salt, to say nothing of some of the metals of less importance. Coal, ores and timber exist in such abundance as to make the question one of the proximity and of the relative quality of the supplies rather than of their abundance and of their existence. The competition is no longer to find coal in excessive abundance; it now consists in a friendly rivalry among those who possess the coal as to which will make the strongest and richest coke. It is no longer a question of the existence of iron ore in such masses as to make the number of tons a matter of no present consequence. The pending question is which ore is the richest or the purest or the best in its situation for immediate use. In respect to the high-grade ores, which may be suitable for conversion into Bessemer steel, it is no longer a question whether they exist or not, but whether they exist in pockets only or in great veins; in either event there is enough in sight and in close proximity to coal to assure the immediate establishment of the manufacture of steel at many points. It is no longer a question whether or not basic steel can be made in the southern part of the iron section; it is only a question whether the right men have taken hold of the matter or not, and whether the right method is being adopted, and of that there can be little doubt. It has been wholly due to the basic process of making steel that the product of Germany has been carried from a little over 2,000,000 tons in 1878 to nearly 4,500,000 tons in 1879.

All these points may be proved by observations right on the line of the railways, but what there is a few miles away is still almost unknown. The surface only has been scratched. Within a week of our arrival at one point a vein of antimony had been opened, apparently yielding an abundant supply of very high grade ore. Copper has been made in past years at several points, and there are claimed to be many workable deposits yet to be explored.

One needs only to go to Saltville, in Southwest Virginia, to touch

the main source of the supply of salt by which the whole Confederacy was sustained throughout the war. A great blue-grass farm is underlain at a depth of a little over 200 feet with a stratum of salt 300 feet deep, which yields a brine of which 22 gallons make a bushel of salt that needs no refining, but which can be placed at once upon the table, or worked in the dairy or by the meat-packer, as it comes from the boiling keirs. Why should not this great deposit soon be employed in the manufacture of alkalies? The supply of hardwood timber is endless, and in the limestone country as soon as the trees are cut away the blue-grass (*poa pratensis*) comes in. At Saltville we saw the largest herd of registered short-horned cattle that there is in the world, whose progeny are being scattered throughout the blue-grass country. The potential in wool on these plains and mountains rests not upon protection against the wool of South America or Australia, but merely upon the protection of the sheep against the dogs which infest every county, and may continue to do so while the population is as sparse as it is now.

The whole wheat crop of the United States is now made on less than 60,000 square miles, but we cannot consume it all if we would. It may be deemed extravagant to suggest, but one cannot help believing that when a sufficient population, endowed with thrift and intelligence, shall occupy the valleys and plateau of the section within the area that I have given, the potential in wheat production of this section may be equal to the supply of all the wheat that the people of this country now consume. One only needs to view the valleys of the Shenandoah, the Roanoke valley, the 10,000 square miles of the so-called "blue-grass" in Kentucky, the Powell River valley, where the town of Harrogate is being laid out, and the many limestone valleys and plateaus which are traversed in other parts of this section on the return over the Piedmont Air Line, to accept even this forecast as only perhaps a little too sanguine or roseate in its terms.

Crude iron is, in itself, a product of small value in ratio to our manufactures measured as a whole—wheat constitutes less than 8 per cent. of the total product of agriculture. It is upon the power which we derive from the production of coal, iron and wheat under the most favorable conditions, at the highest rates of wages and the lowest labor cost—that we may measure our industrial force and predicate our future progress in the conversion of these crude elements of energy into their higher and finer forms.

In many parts of this section the blue-grass comes in as soon

as the trees are removed, and within a space measured east and west from the coast lines of North Carolina to the top of the Roane mountain, 6400 feet above the sea level, may be found examples of the flora and the fauna that are to be found 2000 miles north and south between the St. Lawrence and the Gulf of Mexico. There is one establishment in North Carolina whose representatives claim to deal on a commercial scale in 2500 different varieties of "yerbs and greens." Whether that is a source of benefit to the human race or not may be a question with those who do not buy quack medicines.

What, then, may any one now say as to the progress made in the development of this great section?

There appear to be three classes of enterprise; there may soon be but two. An attempt has been made to build up "boom towns and cities," mainly for the purpose of speculating in town lots. One must speak very frankly on this subject or not speak at all. The writer has been accustomed to very plain speech, especially among his Southern friends; he will therefore venture to give the aspect of some of these boom towns. There would be something irresistibly comic in their appearance were it not also a sign of the disappointments and loss which must ensue from the way in which some of these towns have been laid out. Their comic appearance consists in wide streets being carried across a great open field, at one end of which a huge hotel has been constructed or is in process of construction. Sometimes a single iron furnace may have been put up, or the project of a cotton mill has been presented, and on what purports to be the main street of a future great city, an auction sale will have been held of lots measuring 25 feet front by 100 to 150 feet in depth, on which people have bid from $100 to $300 per front foot. In many cases they have paid one-third in cash, and have given obligations to pay the rest.

An end has come to this method, at least in one instance. The pledge having been given to spend the first instalment of money paid for lots in improvements which have not been made, the courts have lately discharged the buyers from any obligation to pay the remainder of the money. Many of these boom towns are laid out at right angles; the streets are graded without any regard to the contour lines or to the future aspect of the place. They are cities of magnificent distances and of disappointed expectations. One would think from appearances that enough store or shop lots had been laid out to do all the retail business of the whole country

and yet there is scarcely a doubt that even some of these plans will be justified, and that there may be an occasional success even in these speculative enterprises. It is fortunate that the end of this method has come so soon, the reason being that the last thing to be desired in the settlement of a new country is such high prices for town and city lots as may prevent working people from becoming the owners of their own dwelling places. The second class of towns has been carefully planned with judgment and discretion Streets have been laid out with due regard for the contour of the ground. The endeavor of the promoters has been to avoid speculation and to induce a steady and regular growth corresponding to that which has taken place notably at Atlanta, at Chattanooga and also in the environs of many of the older towns and cities throughout this section. Many of these enterprises are under the conduct and control of men of rare capacity and judgment, who invite the incoming of the representatives of the lesser arts, and who do not propose to put up iron furnaces in advance of the supply of ore, or cotton mills without any consideration of the source from which the operatives are to be derived.

The third class of new foundations for city or town consists in the selection of centres to which railways must come or have been brought, where there are the greatest facilities for combining ore, coal and timber, and where the work may be justified by actual proof that cities can be made by a lavish expenditure of money upon an apparently well-devised and well-executed scheme. The future will determine whether great cities can thus be founded or whether they must not be a growth from within outward.

A fourth plan may be adopted. Much interest has been expressed in the suggestion to give a title to lots, on terminable ground rents, corresponding to a system which has built up Philadelphia, to the end that men of capacity and aptitude who have but little money may become the owners of their own dwelling places at a moderate ground rent, terminable at their own option by the payment of a lump sum after a given number of years have elapsed, according to the terms of the conveyance.

Had it not been for the construction of the railway service and the sinking of distance as an element of cost in a fraction of a cent a ton a mile, the people of New England might view the development of the South, and especially of the section which I have described, with some apprehension. We possess what is generally considered a bad climate, a sterile soil, and we have no natural re-

sources of any kind ; we are, therefore, free from all disability and obstructions to our material progress. We cannot depend upon anything but our own efforts, and for that reason we may easily maintain the lead which we now hold in the industrial arts that rest almost wholly upon mental energy and mechanical aptitude for their success.

We are now engaged in a friendly contest, in which each community, each section and each State may attain the greatest measure of prosperity by the exchange of services in that commerce in which both parties make a profit. That is the rule by which all free commerce among men and nations lives and moves and has its being.

It may be deemed almost officious for me to deal at such length with the details of the area which I have defined. My justification must be found in the strange fact that in the very heart of the eastern part of the territory of the United States is to be found an area nearly as large as France, endowed with more varied resources and with a better climate than almost any other similar area within the limits of our common country, which is very sparsely settled, and where the few inhabitants in the rich interior valleys have lived a totally isolated life for so many years as to constitute them almost an alien people in their speech, their habits and their customs. Until within ten years this section was a *terra incognita* to the people of New England, and even now the first experience of many of them will have been gained by the speculative traps into which they have been enticed by the unscrupulous promoters of "boom cities."

This phase has passed, or is passing, and the time has now come for men to comprehend that there lies at our door a very large area of almost unoccupied territory capable of being made the homes of millions of intelligent and industrious families.

It is a territory capable of supplying meats, fruit and vegetables in almost measureless abundance, where yet a large part of the grain and meat are imported from the West, and where one of the most conspicuous blots upon the landscape in the neighborhood of almost every town or hotel is the pile of empty tin cans from which the bad feeding of the people has been derived.

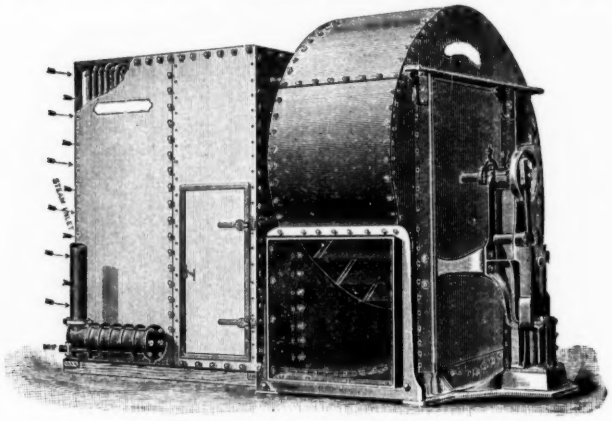
A change may soon come by the substitution of safe land companies, who may build roads, lay drains and expend their capital in solid preparations for wholesome living, and who may then invite skilled mechanics, farmers, market gardeners and artisans who

have the capacity to develop towns and their suburbs in the surest and safest way, to buy their land in parcels of reasonable size on ground rents on which no foreclosure can be made, but which may be terminated after a certain number of years at a given sum. In this way small sums of money may be left as capital in the hands of the occupant of the land for use in productive work, while he will be practically his own landlord so long as he pays the ground rent. When the system is supplemented by the aid of the title insurance company, the building society or the savings bank, many communities may be established in the South, in which all the people will be as well housed in their own homes as the workmen of Philadelphia now are, where all these methods have been long practised, to the end that there is no other city in the world where so many people dwell in comfort in their own homes.—*Manufacturers' Record.*

HEALTHFUL AIR IN FACTORY BUILDINGS.

By Walter B. Snow, M. E.

THE present movement, legislative and socialistic, toward the better protection and greater comfort of employés in all manufacturing establishments, calls particular attention to the necessity for purer atmosphere in shop and factory. That the atmosphere in many factories is neither agreeable, comfortable nor healthful is too well appreciated by their occupants to leave room for argument against the introduction of ventilating arrangements. Odors of oil and grease, emanations from defective sanitary arrangements, destructive acid fumes and manifold noxious gases combine with the air already vitiated by respiration to make

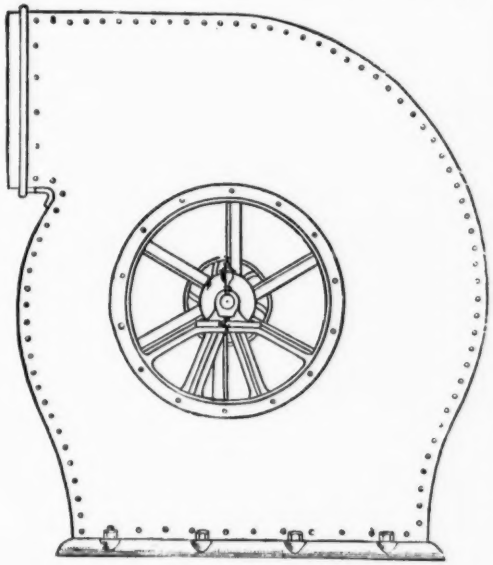


A HEATING AND VENTILATING APPARATUS.

it foul in the extreme. Heating furnaces, steam drying cylinders, open fires and kindred influences overheat it and still further tend to render it disagreeable and unhealthy.

A good neighborhood, healthy surroundings and plenty of room, govern in the selection of a building site for the residence of the proprietor; but the location of the factory in which his workmen labor ten hours daily, is too often decided solely by the low price of the land or by power and railroad facilities. Many are the mills and factories prettily situated beside the rushing streams of the hill country of New England with its superabundance of pure air, but by how great a number are these overbalanced by the

cheaply built and closely clustered shops of her large manufacturing towns. To think of applying any means of ventilation to shops of this latter class has been regarded as nothing short of preposterous. The apparently unanswerable argument of the staid proprietor is: "I've run this shop for forty years without any of your ventilating rigs and I guess I can keep it running on the same basis as long as I live." It is not a question of mere running: it is a vital question of the health and comfort of the employés and of financial profit to the employer. However, public sentiment is likely to control in these matters, and whether the manufacturer will or no, he may be compelled to give attention to this subject.



A BLOWER WITH HORIZONTAL TOP DISCHARGE.

But, aside from the humanitarian standpoint, may it not be possible that even the mercenary minds of some manufacturers can be convinced of the advisability of providing pure air in sufficient volume for the proper comfort of their employés? It is difficult to obtain authentic data in support of this view, but the following figures from the records of the Pension Bureau at Washington, D. C., are decidedly suggestive. In the old building, with no special means of ventilation, the time lost in one year, by the absence of clerks on account of sickness was 18,736 days, while in the new building which is thoroughly ventilated by the blower system, the loss was only 10,114 days, and that with a larger working force.

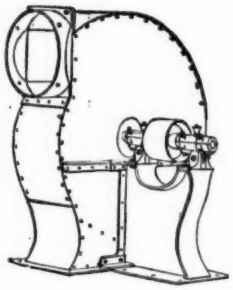
In the Northern States, some means of heating must always be

considered a necessity, although the extent of the heating may vary even to the limit set by a ship-building concern in West Superior which recently placed an order for an apparatus to take the chill off the air in one of its large sheds, by heating it from minus 30° or 40° F. up to zero.

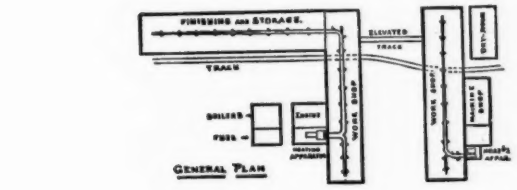
Of the many systems of heating by stoves and furnaces, by direct or indirect coils, by runs of pipe overhead or along the side walls ; or of ventilation by natural agencies or induced currents in heated flues, no description will be here attempted. Heating and ventilation are both necessary and the so-called "blower system" in which they are combined, will be accepted as logically defensible and practically economical and efficient in all cases where *ordinary* ventilation is required, the plenum or pressure method of applying this system being furthermore accepted as unquestionably superior to the exhaust method under the above stated conditions.

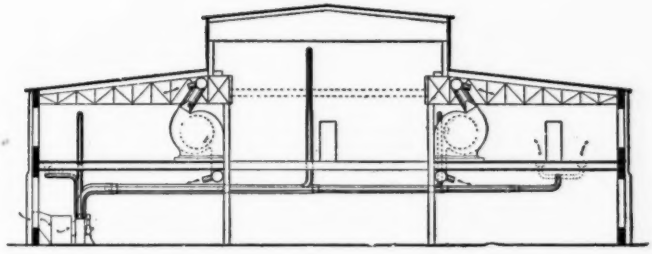
Reduced to its primary parts or elements, the blower system comprises a fan, a motor, a heater and a system of hot air distributing ducts, the latter becoming unnecessary under certain conditions.

The ordinary paddle fan is usually employed in connection with this system. Although a fan of this type may be very efficiently



arranged to draw the air from the desired source and discharge it into the general distributing chamber in which it stands, yet for factory purposes a cased fan is almost invariably used ; the rim of the case being constructed in the form of a scroll, constantly increasing





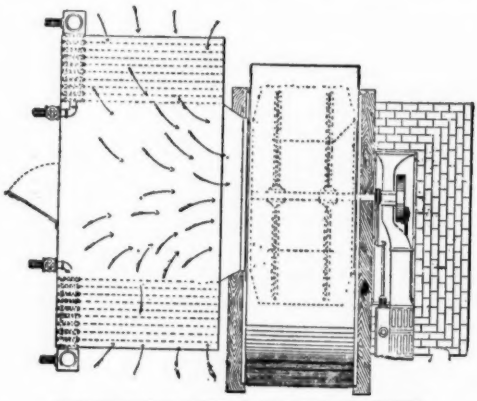
its distance from the centre as it approaches the outlet of the fan.

The compact form and specially located outlet of such a fan greatly facilitate connection with the distributing ducts. With a fan of this description it is possible to produce, without excessive speed, an air pressure of one ounce per square inch, and therefore, to operate against this pressure or resistance. A disc or propeller fan is only efficient under low resistances, and its action is seriously affected by heavy winds or by even moderate lengths of connecting pipes.

The necessity for the use of steam in the heater and the almost universal presence of a steam boiler in any factory render it natural that a steam-engine should be the motor most generally applied. Electric motors for fan propulsion are especially serviceable in public and similar buildings where ventilation is required without heat or where a low steam pressure is maintained. The fact that the exhaust from the fan engine—being practically as efficient for heating as live steam—is utilized in the heater, renders the steam-engine by far the most economical motor that can be selected. For factory work, the engine is usually connected direct to the fan

shaft, and the heating and ventilating apparatus is thereby rendered independent of any other motive power.

A popular form of heater is constructed of independent sections of steam pipes or tubes (radiators) screwed into cast-iron bases. These are made up into groups and encased in a sheet-iron jacket connected either with the inlet or outlet of the fan, according as the air is to be drawn or forced over and brought into contact with the surface of the pipes. A common type of this apparatus is represented in the cut on page 462.



OUTLINE PLAN OF A NEW STYLE OF FAN AND HEATER.

Many factors must be considered in determining the size and location of the apparatus, and the arrangement of the hot air pipes or flues, and each of these factors is variable as affected by local and special conditions. Looking first to the ventilation of the building: a fan should be selected of sufficient capacity to furnish at least 30 cubic feet per minute per occupant, and a greater amount in proportion to the presence of noxious gases. In an ordinary schoolroom such an air supply represents a renewal of the volume about every eight minutes. In the average factory, such as a textile mill or a machine shop—in which the principal vitiation of the air proceeds from respiration—the greater separation of the occupants necessitates a change of air only every half hour or over to fulfill the above condition of 30 cubic feet per head per minute. Shoe shops, shirt and clothing manufactories and the like usually demand a more frequent change of the air, owing primarily to their more crowded condition.

Independent of the ventilation, satisfactory heating by the blower system requires, in cold weather, a change of air every 15 to 20 minutes, so that in the average factory, estimate of air supply per head very seldom enters into the calculation, the provision of a sufficient delivery of air for heating purposes far more than

meeting the requirements of ventilation. The ventilation thus becomes incident to the heating, and so intimately connected with it that it cannot be considered as a separate system, and cannot be assumed to cost anything over and above the expense of heating.*

In order to accomplish the heating with a volume of air sufficient only for the requirements of the operatives, it would be necessary to heat that air to an excessively high temperature, an undertaking that is neither economical nor satisfactory. Successful heating and ventilation must be accomplished with large volumes of air at moderate temperature.

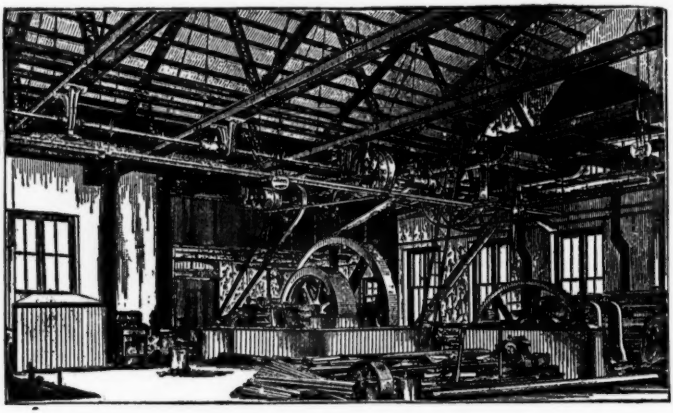
As in all other classes of heating work, the size of the heater itself is dependent upon the character of the building; the material of its construction, its size, its exposure, amount of window surface and the nature of the work carried on within it. This latter item is assuredly worthy of more consideration than it usually receives.

A man whose work calls for constant movement and violent exercise certainly neither requires nor desires an atmosphere of the temperature that would be agreeable to the man who remains quietly seated throughout the day. The effect of forge fires in blacksmith shops, of furnaces and hot iron in rolling mills, of gluepots in pattern shops, of hot sand and castings in foundries and of large quantities of rapidly moving machinery as in textile mills, is often evident to a marked degree.

A record of temperatures in a certain manufacturing establishment, taken during the cool fall weather before the heating system was in operation, revealed the fact that in the morning the temperature of the foundry usually exceeded that of other portions of the shop by ten to fifteen degrees. It is well known that in textile mills, particularly in the spinning rooms, little heat is required in moderate weather.

One of the marked advantages of the blower system lies in the

*Of course it is freely admitted that where heating is performed by steam specially generated for the purpose, the introduction of fresh heated air from the exterior of a building with simultaneous discharge from the interior of an equal weight of air, is more expensive of fuel than any system wherein the reheating of air by repeated circulation over warm surfaces is accomplished. In the first named method, the air must be heated sufficiently to change its temperature from that exteriorly existing to that at which it it is desirable to deliver it into the space to be heated. In the second method, the air has only to be heated to the desired temperature from the temperature at which it passes from the warmed space to and over the heating surface.



APPLICATION OF THE OVERHEAD SYSTEM TO A ONE-STORY SHOP.

greatly reduced area of heating surface required for a given work. Owing to the large volume of air brought in contact with the heater pipes there is condensed from three to four times as much steam per square foot of heating surface as in direct runs of pipe around the building. Consequently efficient factory heating by the blower system may be based upon one square foot of heating surface in the heater to 350 to 700 cubic feet of space in the building.

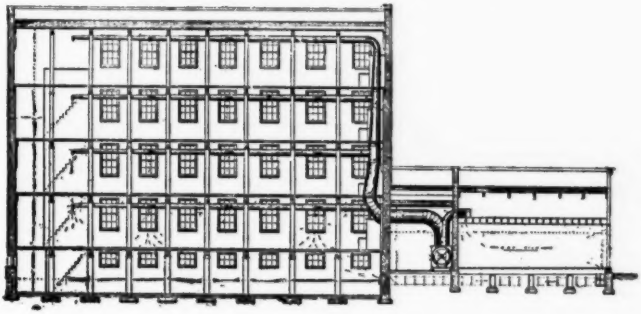
Naturally the simplest structures requiring heat and ventilation, are those of the ordinary one-story railroad shop type, generally provided with monitor roofs, and having large wall, roof and window surface per cubic foot of enclosed space. The high walls and sloping roof demand that the air should be delivered near the floor. To this end, the apparatus is preferably located on one side midway of the length of the building, or overhead on the roof trusses, and the air distributed by means of a pipe hung above the windows and running entirely around the building, delivering the air downward by vertical branches extending to within about five feet of the floor. In the rolling mill herewith illustrated, the apparatus was supported upon the roof trusses and the downwardly extending pipes were flattened so as to occupy no valuable space by projecting into the room. It is feasible in a shop of this character to heat and ventilate from a single central pipe.

The air delivered under either arrangement is discharged at or towards the cold outer walls, whence it gradually passes inward

and rises to the monitor where an outward current through crevices is readily effected. In such a building the air supply is so far in excess of the requirements of the occupants that economy in steam can be secured, without detriment to the ventilation, by taking the air supply for the fan directly from the building; that is, by simply turning the air over and over. Even with this arrangement there is always a constant—although slower—renewal of the air within the building. In fact a Massachusetts State Inspector recently made the statement that a certain Fall River cotton mill in which this custom prevailed was one of the best ventilated buildings in the State, and that not one schoolhouse in ten contained such good air for breathing purposes.

In the gallery type of one-story shop, so popular at the present time, an arrangement of apparatus and piping may be made very advantageously as a rule; an apparatus being placed in each gallery and so arranged as to discharge upward and downward into piping systems extending the length of the building, and discharging toward the outer walls. As the centre space is entirely utilized by a travelling crane, no cross pipes can be permitted; and where a single apparatus is employed, connection between the sides must be made either at the ends or beneath the floor.

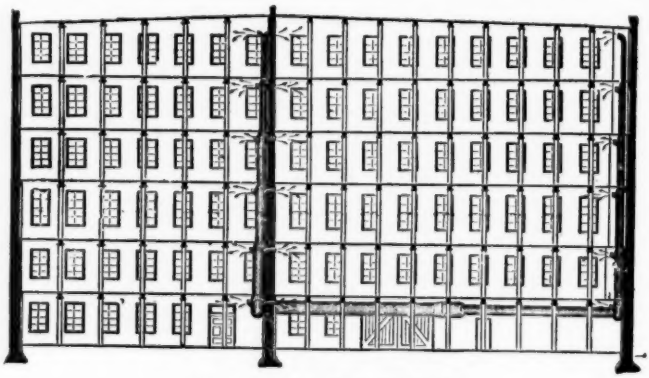
The size and shape of a factory of more than one story practically decide the arrangement of the system to be adopted. Tin or galvanized iron distributing ducts, must, almost of necessity, be employed in a building already erected. But in the case of a new factory of brick or stone, the wise and progressive owner will give careful consideration to his heating and ventilating system in the



DISTRIBUTION FROM CENTRAL PIPES.

original planning of the building, and will arrange for distributing the air by means of vertical brick wall-flues, occupying no valuable floor space, adding but little to the cost of the walls, and forming permanent and non-destructible air passages.

Such wall-flues are usually constructed in the form of external pilasters between the windows, and are spaced some 60 to 75 feet apart along one side of the mill only. In its most approved form the outside brick pilaster flue, consists of a four-inch internal wall well smoothed within, a one or two-inch air space, and an external eight-inch wall thoroughly bonded into the interior wall. Connection is made at the bottom with the main sheet iron or brick duct from the fan, and the discharge of air to the rooms



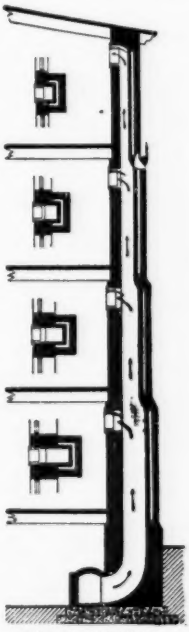
APPLICATION OF THE STAND PIPE SYSTEM.

takes place through openings eight to ten feet above the floor, provided with dampers or gates for the proper regulation of the air supply.

Contrary to the supposition of those unacquainted with the system, the distribution of air and heat is exceedingly uniform. The three-story weave shed of a certain Lawrence cotton mill,—as it was before addition was made,—affords an excellent illustration of the fact. The building was about 400 feet long by 70 feet wide, with 13 foot stories, and was entirely heated and ventilated from four outside pilaster flues. The opening from each flue to each floor consisted simply of a slit 16 by 24 inches; an opening that would hardly attract one's attention in passing through the mill. The difficulty in the way of distribution was apparent to the

observer when his eye caught a second narrow slit nearly one hundred feet distant, and he realized that through four such openings, equal only to a single inlet two feet square, was discharged the entire air supply for the room.

Yet carefully recorded readings of the temperature at various times of the day showed, in the case of forty readings taken at random from the record of four successive days, an average maximum difference of only 4. 61° between the floor and ceiling, at the middle and both ends, and of only 2. 13° when the readings at the severely exposed west end were omitted. Much of the equality of this distribution was obviously due to the large number of rapidly moving belts, pulleys and looms.



THE PILASTER FLUE.
Applied to four story build'g.

Where one end is well protected and the building is narrow, an outlet at the protected end, discharging the air directly down the length of the building, has proved itself as efficient as a complicated system of piping. The room then becomes a large conduit for the air which is equally distributed throughout its length and breath. In one shop in which this 165 ft. distant arrangement was adopted, the windows at the farther extremity were frequently opened on account of the excess of heat, while the temperature of the room near the air inlet was only normal.

In no case of ordinary factory ventilation by the plenum system, are vent flues necessary ; the pressure created within the building always being sufficient to produce the required discharge and effectually preventing the entrance of noxious gases from adjacent apartments.

Instead of attempting to remove by exhaustion the annoying steam ever present in dye-houses and bleacheries the blower system supplies warm air in sufficient volume to serve as an absorber of the moisture arising from the tubs and vats, thereby, not in reality, *preventing* the steam, but rendering it invisible—which is the ultimate point to be attained. This moisture laden air is, of necessity, allowed to escape from the room as rapidly as possible.

A TYPE OF PADDLE FAN.

Forge shops, emery grinding rooms and similar places where the production of smoke, gas or dust is local are not included among those in which the plenum method of applying the blower system will meet the requirement. They can only be satisfactorily ventilated by exhaust fans connected by pipes directly with the hoods around or above the generators of the objectionable element, be it smoke, gas or dust.

How does the blower system compare in first cost with other systems of heating and ventilation? Such is the question that must naturally arise in the mind of the reader. As naturally may it be replied, that it is impossible to make a specific statement, as the following circumstance well illustrates. In a certain city are two buildings similar in size and construction, very satisfactorily heated and ventilated by the system herein described. In one case the blower system cost about one-half the estimate for direct steam; in the other the price was fully 40 per cent. in excess of the direct steam bid. In both instances the decision was made upon the merits of the system and not upon the relative cost. But it must be borne in mind that the direct is simply a heating system while the blower system includes the ventilation with the heating.

The cost of operating is largely dependent upon circumstances. When exhaust steam, which would otherwise be thrown away, is utilized, certainly nothing can be charged to the operating expenses of the system. In the use of live steam there is, as in steam-engine practice, ample opportunity for variety in the amount of steam consumed to accomplish a given result. Assumptions are plenty but facts are few. However, the results of a six months' trial at a prominent Fall River cotton mill are pertinent and reliable.

Of two mills under the same management and of very nearly the same size and exposure, mill No. 1 was fitted with an over-

head direct steam heating system and No. 2 mill with the blower system. The coal consumed for heating alone in No. 1 mill was in the ratio of 100 to 64 burned in No. 2 mill for both heating and ventilating.

In favor of the blower system it may with reason be claimed that in first cost it does not on the average exceed other systems of mere heating; and in operating expense it is below other combined heating and ventilating systems of equal efficiency. It masses the entire heating surface in a fire-proof case, avoids the danger and inconveniences of leakage, freezing and hammering in pipes distributed throughout the building, is easily operated and can be controlled by a single valve. It is always positive in its action, and independent of the conditions of the outside atmosphere. It furnishes large volumes of warm air to meet all demands, maintains permanent control over the source of air supply, causes all leakage to be outward and compels an equable distribution of heat and air. In summer it is capable of perceptibly cooling the atmosphere of the shop or factory. As the ventilation and the heating go hand in hand, no reasonable charge can be made for the cost of ventilation, as under ordinary circumstances effectual ventilation by the blower system must be the result of efficient heating.

The adaptability of the system to all classes of manufactories has been fully established, its claims are well grounded and the benefits accruing from its introduction are far-reaching.

There is no longer any excuse for subjecting the foundry-man to the choking fumes of the pickle house, to the suffocating dust of the rattlers or to the debilitating effects of an overheated atmosphere. The emery grinder and polisher, the workers in the plumbago mill, the girls in the shoe shops and clothing factories, all have a right to demand protection from the dust and the overheated and vitiated air that so insidiously undermines their health. Workers in all trades have reasonable cause for complaint when they are compelled to labor in an objectionable atmosphere. Means exist and can be applied to prevent this continued bodily annoyance and injury. The shoe buffer has long had the fine leather dust removed directly from his machine by a small exhaust fan, the cotton picker has its provision for dust removal, the flour mill is not without its fans, and almost every planing-mill is provided with an exhauster which incidentally, rather than intentionally is a benefit to the workmen; but, notwithstanding, there remains a host of factories in which men and women are compelled

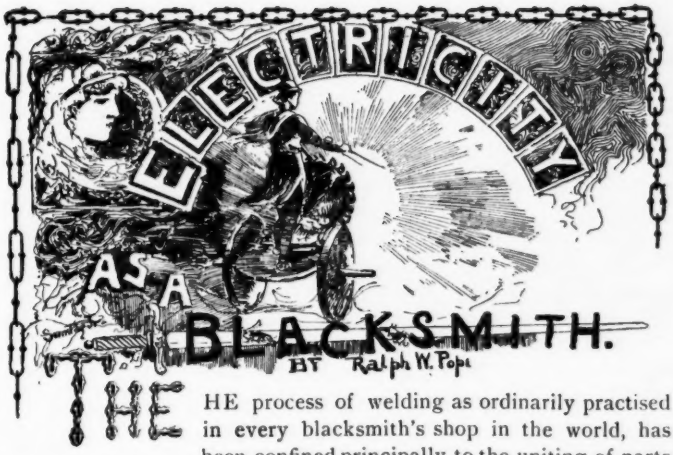
to labor in a deleterious atmosphere that can be and should be purified.

[NOTE.—In the June number of the *Contemporary Review*, London, there appears a very notable paper entitled "Bad Air and Bad Health," by Howard Wager and the Hon. Auberon Herbert, with letters of comment from Professor Huxley, Sir Lyon Playfair, and others. In the opening paragraph the authors say:

"The purpose of this paper is to utter a warning against the careless way in which the great mass of people, poor and rich, ignorant and learned, allow the air of their living-rooms to be in an impure condition, and to point out the great sacrifice of energy and health which results from this carelessness. We shall try to show that there is strong ground for believing that not only a large part of the ever-increasing trouble of bronchial and lung affections, but also a very large part of that vague and subtle ill-health which troubles our modern lives in varying forms, is to be placed to the account of the impure air which we so habitually breathe."

Further along they say:

"We suspect that not only liability to cold, but gout, rheumatism, lumbago, neuralgia, some forms of headache, and many forms of nervous irritation are to be conquered by constantly giving lungs and skin a fair chance of getting rid of these poisons; we feel sure that the irritable temper that so often accompanies severe literary work, and at last ends in the "break-down," must largely be put to the account of the impure air breathed through long hours; and we suspect that much of the intemperate drinking in towns results from the depressed feeling which follows work done under similar conditions. We think a great society should be formed to arouse the interest of all classes in this subject, and that inquiries should be made—the answers being published—as to the provision for fresh air existing in hotels, concert-rooms, theatres, schools, churches, etc. We are, both of us, opposed to action being taken through State inspectors. The present evil will never be really overcome until individual interest is aroused; and the State inspector does not develop individual interest.—EDITOR.]

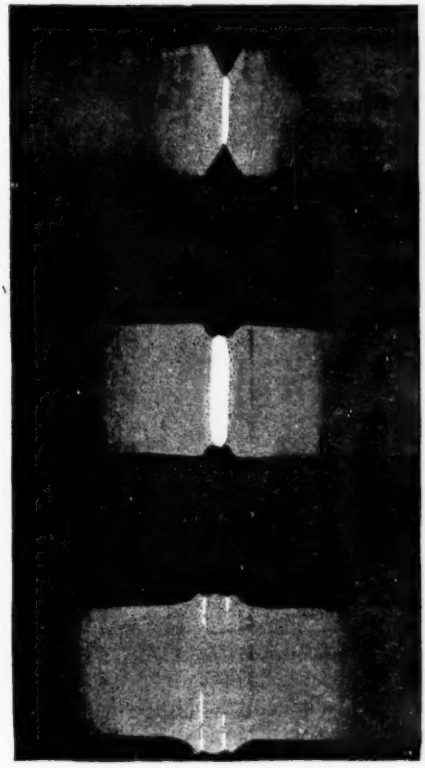


THE process of welding as ordinarily practised in every blacksmith's shop in the world, has been confined principally to the uniting of parts of wrought-iron, and also in a less perfect manner to those of mild steel. Simple as the operation may appear to the casual observer, it requires great skill on the part of the smith, who must have learned by long experience to determine accurately the proper temperature at the right spot, and to carefully prevent the accumulation of scale which would cause imperfect work. Without asserting that welding by electricity will entirely supersede the time-honored hammering process, it may be shown that it possesses so many peculiar advantages, that its general introduction in manufacturing establishments where large numbers of welds are required, is but a question of relative cost of the two systems, considering all the advantages offered by each.

The mere fact that two pieces of metal could be electrically welded, as for instance the ends of wire, has doubtless been familiar to many electrical experimentalists since the discovery of the electric arc by Sir Humphry Davy in 1810. Its actual development in a practical commercial form, however, is due to the genius of Professor Elihu Thomson, whose attention was first directed to the utilization of electricity in this manner by the joining of two wires in the course of some experiments at Philadelphia in 1877. Subsequently, in the construction of dynamos he realized the importance of making good joints in copper wire, as it was at that

time impossible to obtain wire of proper size in more than 50-pound lengths, while 300 lbs. were required for some of the coils used. Even with the exercise of the greatest care the necessary joints made in the ordinary manner were sometimes imperfect. Professor Thomson was thus led to consider the possibility of welding the ends with the aid of electricity. It should be understood that the welding of copper by the ordinary method was practically impossible, and that a soldered or brazed joint was then and is now resorted to as the best obtainable electrical connection under ordinary conditions. The quantity of current required to raise the temperature of a large copper wire to the necessary degree was one of the first difficulties encountered. While it was an easy matter to obtain sufficient current to heat a small wire, it was not then practicable to develop such quantities as are now generally used in electric welding. No dynamo at that time produced over say 500 amperes, while 40,000 amperes of current are now readily obtained through the agency of a transformer.

The basic principle of electric welding will be seen to lie in the development of heat by the passage of an electric current of large volume through a conductor of high resistance to its passage. One of the simplest lessons in electrical practice is that metallic contacts of small surface if lightly pressed together offer considerable resistance, which is lessened with the increase of the surfaces in contact and of the pressure exercised in forcing them together. The practical problem of electric welding is apparently complicated by the fact that with the heating of the metal through which the current flows, its electrical resistance is reduced. It is, however, necessary that the current be properly regulated as the weld progresses, and a device for this purpose is provided, under the immediate control of the operator. In order to secure the best results, and at the same time enable the operator to watch the formation of the weld, the two ends of the metal parts to be joined should be slightly rounded, so that the first contact is made by the touching of the centres. The current immediately begins to flow, the metal is heated at the welding points, and the two parts are forced together under continual pressure until the weld is complete. In practice, the time required for this operation is so brief that the red heat travels but about one inch from the weld. By first making the connection in the centre as described any scale which may be formed in the process is forced outwardly, and the completed weld is perfectly homogeneous, a burr being raised at the junction

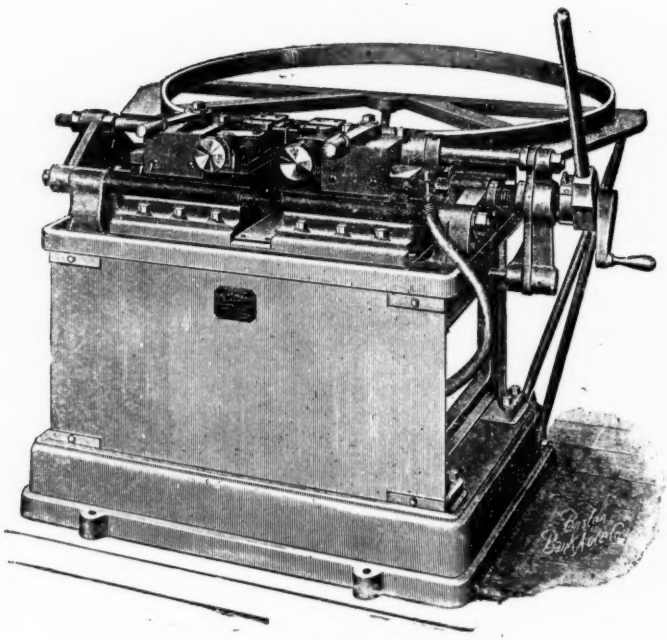


THREE STAGES OF AN ELECTRIC WELD.

which should be hammered down while hot or removed by proper tools when cold. The different stages of the operation are shown in the accompanying illustration.

The time required for making welds of this character, using $1\frac{1}{8}$ inch round iron is divided as follows: Inserting in clamps 15 seconds; heating, making weld and removing from clamps 40 seconds; hammering by hand on anvil 30 seconds; making a total of about $1\frac{1}{2}$ minutes. By the use of a power hammer this time may be decreased. No difficulty is experienced in making welds showing 96% of the strength of the original material. Detailed figures given by an English firm, using one electric welder, show a saving of 34% over the fire method.

In order to simplify this description of the process of electric welding, the examples referred to have been of such a character as will be most readily understood. The practical utility of electric welding, however, appears at once in its application where the metals used can be welded by no other process to advantage, as in the cases of copper or aluminum. The form of the parts to be welded, the quantity to be treated, and the location of the work, the availability and cost of power, are all factors in the economical problem presented. Electric welding has now been brought to



WELDER FOR WAGON AND CARRIAGE TIRES.

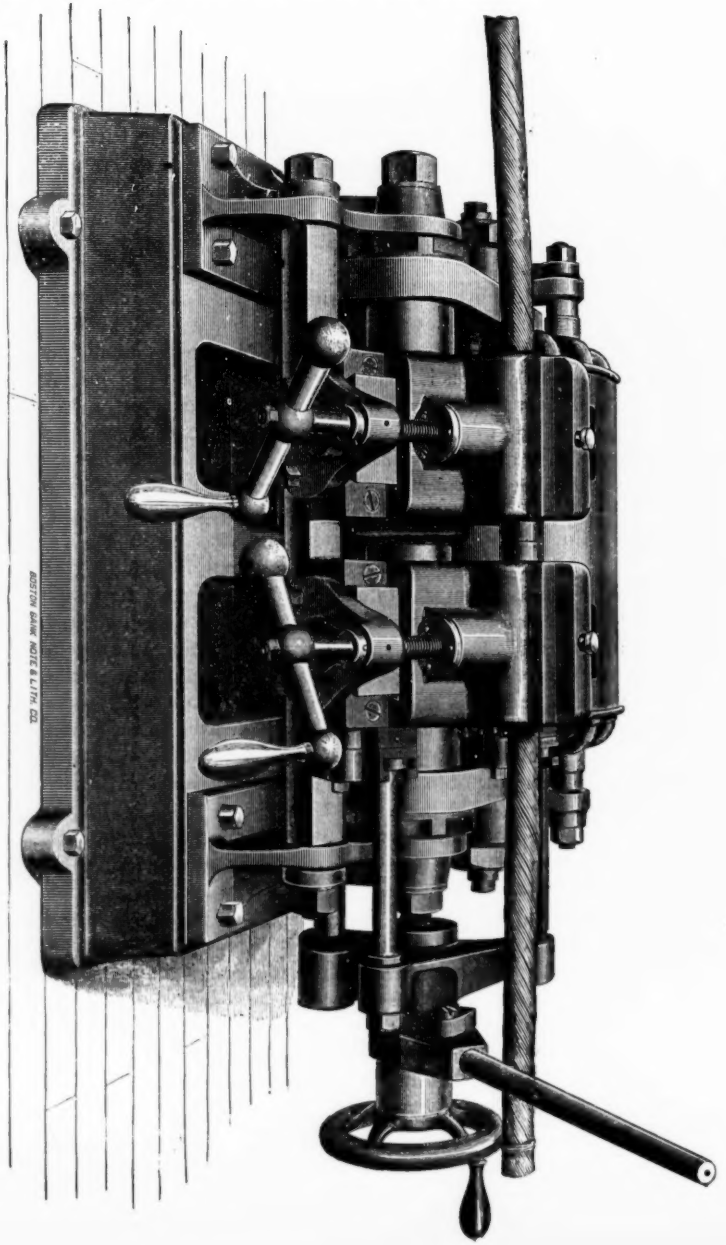
such a stage of perfection that it is in daily practical operation in numerous establishments, and for various purposes. At a bicycle factory in Hartford, Conn., a welding machine is used for brazing the tubular limbs into the Y-shaped fork of the front wheel of the bicycle. The fork is a nickel steel casting into which two tubes are brazed. Each tube is put into its socket, and two or three turns of fine brass wire wound around it. The tube being held in one clamp and the socket in another, the passing current melts the wire, which finds its way into the crevices and an excellent brazed joint is made without the exertion of any pressure. This process was found so satisfactory, that it was proposed to alter the design of the bicycles in order that all possible parts might be brazed in the same manner. A western establishment manufactures wheels for agricultural machinery the spokes of which are all welded to the hub simultaneously. A company has also been or-

ganized for the special purpose of making steel pointed shot and shell for ordnance use.

As it was the requirement of perfect joints in copper wire which led to the conception of the process of electric welding, it is in this field that it has been most highly appreciated. The electrical test of wire for conductivity is the best known means of determining the homogeneity of the metal from which it is drawn. The one-hundredth part of a mile is generally required from the manufacturer for these tests. On one occasion three samples of wire were submitted, one of which was made of fifty pieces electrically welded together, the others being continuous lengths as ordinarily drawn. The three samples passed the test equally well. Brass wire joined in this manner with an ordinary butt weld may be perfectly drawn. When this is done no trace of the weld remains. At one establishment a machine is almost continually occupied for the express purpose of welding together bits of wire to be redrawn which would otherwise be available only as scrap. What is known as the "fifth wheel" of a wagon is now welded by electricity at the works of the New York Fifth Wheel Company. This so-called wheel is a ring made of channel section iron, about $2\frac{1}{2}$ inches by 1 inch, and $\frac{3}{8}$ inch thick. It is bent round cold to a diameter slightly larger than it is to retain when finished. The two ends are held in the clamps, pressed together, and the current passed through, as in the case of straight bars. From the time of putting in the ring until it is taken out, including some hammering, about four minutes elapse. The burr is then ground off on an emery wheel, occupying three minutes more or seven in all. According to the statement of the blacksmith in charge of this work, he was formerly obliged to flatten down the two sides of the trough-shaped iron at the ends, then scarf-weld them and hammer up the edges again, the whole operation occupying from 35 to 40 minutes; so that the saving in time in this class of work is very considerable while the quality of the welds is decidedly superior. The application of the process to the welding of angle-iron frames and similar parts of constructive work is clearly possible.

In the welding of wire cables, a short piece—say from $\frac{1}{4}$ to $\frac{1}{8}$ of an inch—is made solid. Tests of joints of this character have been made showing 78 per cent. of the strength of the original cable; a very large percentage for this class of work.

It will be seen that with this process automatic welding machines are possible, and they have been brought to a high degree



WELDER FOR STEEL WIRE CABLE, RODS OR BARS OF IRON OR STEEL.

BOSTON BANK NOTE & L/TH. CO.

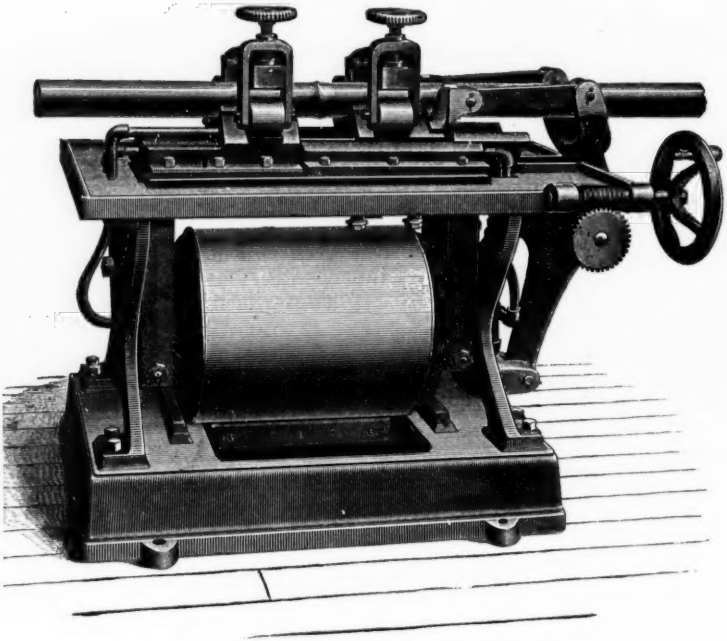
of perfection. They have proved to be especially adapted for metals which are readily fusible, and have made possible the successful welding of aluminum, silicon and aluminum bronze, which require considerable skill even with the electric process. The conditions influencing the perfection of the work vary with different material and sizes. Among these conditions are the projection of the abutted pieces beyond the clamps; the electromotive force of the welding current; the end pressure applied to force the parts together at welding heat; and the interruption of the current at the proper moment.

The end pressure required during the welding process is the most important factor in the perfection of the joint. If the pressure necessary for a given size and material is used, the weld cannot be made until the metal has acquired the proper plasticity to yield to the pressure. The pressure required is approximately 1800 lbs. per square inch for steel; 1200 lbs. for iron; and 600 lbs. for copper. The interruption of the current immediately upon the completion of the weld is very important in the case of metals which are easily fused, otherwise the metal will be melted and the joint destroyed. It is also frequently necessary that the parts to be welded should be of a certain fixed length. These conditions are provided for in an automatic welding machine.

The development of the automatic principle to a high degree has been attained experimentally, and applied to the manufacture of rings and chains. The original model of a machine of this character produced 250 feet of small chain in a day with very little attention, the plain wire being introduced at one end of the machine and appearing as completed chain at the other. A piece of this chain enlarged to a little more than its natural size is shown in the cut used as a tail-piece.

The appearance of this chain would indicate that the links are formed by the uniting of two U-shaped parts. This is not the case however. The link is originally C-shaped; but it is less difficult to clamp the link across its entire width than merely on one side, the consequence being that the metal is also heated opposite the opening, and thus the pressure brought to bear to form the weld also squeezes together or "upsets" the hot metal where it is whole, this forming a "burr" exactly opposite the weld. A machine is also now in use which makes chain having links formed of two-inch iron and ten inches in length.

The electric welding process has made it possible for operators



WELDER FOR STEEL OR IRON PIPE.

not especially skilled in blacksmithing to make good substantial welds, not only with wrought iron and steel, as formerly, but also with cast-iron, wrought and cast copper, lead, tin, silver, zinc and gold. Among the alloys welded have been steel of all grades, brass, German silver, and various grades of gold. Perhaps most interesting of all, however, are the combinations which have been made possible, among them being, copper to brass, to wrought iron, to cast-iron and to gold; tin to zinc and brass; wrought iron to cast-iron and to cast-steel. In fact, without specifying the examples it may be assumed that all metals and alloys, or their combinations, may be electrically welded.

The possibilities of electric welding are by no means confined to small work. Machines are now made which will weld one inch bars of copper, eight square inches of iron, and six-inch heavy

wrought iron pipe. The electric welding of steamship shafts and of steel rails is confidently predicted, so that the future growth of the art may be looked for in every branch of industry where hammer welding is now practised, as well as in a multitude of cases where it has been impossible.

THE IRON AND STEEL INDUSTRIES OF AMERICA.

By Sir James Kitson, Bart.

THE British Iron and Steel Institute has several times during the last twenty years held its autumnal sessions in some foreign country. The objects of these international meetings are to enable the members to compare the metallurgical processes adopted in different countries, to investigate the results which attend the more scientific methods of foreign manufacturers, and generally to keep in touch with the progress of the iron and steel industries throughout the world. It has always been the custom of members of the British iron and steel trades to cordially welcome their foreign friends and competitors, and freely permit them to visit our factories and examine the methods of our production; and these foreign friends have always been ready to reciprocate the courtesies shown to them in England.

In the autumn of last year, the president, council, and 295 members of the British Iron and Steel Institute, and several members of the Institute of Civil Engineers, together with 142 members of the Verein Deutscher Eisenhüttenleute, crossed the Atlantic to hold their annual meeting in America, and experience the bountiful hospitality of their American friends. That expedition was in many respects the most remarkable which the Institute ever undertook, and I propose to give a few jottings on the incidents and the impressions of our tour. Alike in the number of visitors, in the extent of territory visited, and in the number of works and mines examined, it was the largest expedition ever undertaken by the Institute, or by any scientific society in Europe.

We arrived in New York on September 29. A reception committee, of which the Hon. Abram S. Hewitt, president of the American Institute of Mining Engineers, was chairman, was ready to receive us. From the time we passed Sandy Hook until we boarded the *Servia* to return, we were the object of unremitting attention from our hosts. Everywhere we were received with princely hospitality. Everything possible was done by our American friends to make our visit pleasant. Special trains and carriages were placed at our service. Brilliant receptions and the most sumptuous banquets

were held in our honor. Every town we visited had its reception committee awaiting us, and presented each member of the party with a special guide, giving us the history and present position of local industries. We were embarrassed by the enormous numbers of invitations which we received. Towns competed for our presence, and vied with each other in the grandeur and cordiality of their receptions. The ladies of the party were systematically cared for by several committees of ladies, who provided hospitality and made known the various objects of interest in the cities and States visited. It is not easy to describe or do justice to the magnificent way in which the Iron and Steel Institute was received in America.

Two days were spent in New York, and the visitors had some opportunity of seeing this great commercial city. What strikes the visitor most about New York is the excessive activity of the people. The movement in the streets is phenomenal. There is an interminable rush and bustle in the business quarters. Every one seems to be in a tremendous hurry and bent on making up for lost time. The pavements are thronged, and the street cars always crowded. Special means have been adapted to facilitate the rapid movement of the citizens, but these are not adequate to meet the needs of this busy people. The configuration of the site on which New York stands cramps and compresses the business quarters. The city is built on an elongated island, and the current of human activity can only flow in two directions. The elevated railway is not an artistic structure; but it is a necessity. There is a general impression that this overhead railway passing in front of the houses has caused a depreciation in the value of property along the route. We were assured that this was not so. The railway brings the shops and warehouses in the centre of the city into direct communication with the habitations along its course, giving thus facilities to a vast population, and the increased value of the business premises in the lower floors has more than compensated for the fall in the value of the upper storys. The system of tramcars in New York is also well managed, but the condition of the streets is atrocious.

Before leaving New York, we visited Edison at his workshop at Llewellen, New Jersey. Edison is in association with a syndicate, and has apparatus, laboratories, an ample staff of assistants, and all the funds he requires. Every possible facility is given to him for purposes of research and invention. When his idea is worked into

a practical form for commercial application, he passes it over to the workshops, and does not concern himself with simple manufacturing. Edison at the time of our visit was studying an electric locomotive which he had been commissioned to produce for a belt or city railway. He was sanguine that he could produce an electric engine capable of grappling with railway traffic in large towns, and thus abolish the smoke and whistle of the locomotive engine. He stated that he was confident that he could design a practical electric motor which would be capable of a general application to vehicular street traffic. He was engaged in extensive experiments for the selection of magnetic ores of iron. His method was the use of a belt, electrically magnetized, by means of which rich ore was separated from lean ore when passing in a pulverized state over the surface of the magnetized belt. By this means he hoped to make commercially valuable ores containing in the bulk as little as 10 per cent. of iron.

Philadelphia was next visited. Here we found a city of a different type from New York. There is a greater appearance of comfort amongst the working people, and the city bears the aspect of a prosperous community of several generations. The educated people of Philadelphia live in the midst of considerable culture and refinement. That society was in a more settled state than in New York was evident from the character of the buildings, and from what may be called the West End appearance of the best quarters.

Much interest was taken by the members of the Institute in the Baldwin Locomotive works which are undoubtedly the biggest locomotive works in the world, turning out engines at the rate of 700 to 800 per annum. With regard to this enormous output it is fair to explain that the American system permits of the production of a very limited number of types of engines, whereas in England different railways require distinct types of engines. The constant change of form and pattern in English engines tends materially to restrict the output.

At these works the English visitors had the first opportunity of seeing the skilled American artisan at work, and of judging the comparative capabilities of English and American workmen. Every one agreed that the American skilled artisan puts forth more physical effort and produces more work in a given time than the English workman, or the workman of any other manufacturing community. This fact struck me and many experienced directors

of works most forcibly. Before concluding our tour I had the opportunity of verifying and strengthening this first impression. After watching the American workmen at Pittsburg and elsewhere I arrived at the same conclusion as to their efficiency. Their productive power is greater than that of the English workers in the same time, and their working hours are longer, and their remuneration greater. I met one of my old workmen at Mr. Carnegie's works in Pittsburg, and he endorsed my opinion. Speaking from his own practical experience: "I am quite a different man here," he said, "from what I was in the old country; I don't know why it is so; whether it is that I live in a stimulating atmosphere, or whether it is the example set me; but I know I have got the go in me here. I can do more work; I feel that I have it in me; but I also feel and I know that it won't last. I shall be done in ten years." No, it won't last. The extreme physical effort put forth results in greater production, but it saps the vital energies and cuts short the career. This continual work at high pressure does not pay in the end. "It won't last"; and the remark applies with equal force to the employers as well as to the workers. Competition between manufacturers is keener than in this country. They work their business at high pressure. There is a terrific struggle between them for possession of the markets. They put forth their utmost energies, and when they succeed, their reward is great; but all cannot be the leaders in industry. This fierce competition reacts on the men. We were surprised to find in a democratic country like America that the workmen had so little power, and were to such a large extent the docile instruments of energetic employers.

The "bosses"—as the foremen and managers of factories are called—drive the men to an extent that employers would never dream of attempting in this country. There are trade unions, but they do not seem able to protect the men in this respect. The "bosses" have the faculty of "driving" the men and getting the maximum amount of work out of them, and the men do not seem to have the inclination or power to resist the pressure. American manufacturers thus get the greatest possible service out of their plant.

From Philadelphia we travelled by night to Altoona. Here we visited the Juniata works, where the locomotives and freight cars are built for the service of the Pennsylvania Railroad Company. The most noteworthy things in connection with these works were the ingenious mechanical devices employed. All the tools which

are used for shaping and finishing the plates are worked by hydraulic pressure. The great variation in atmospheric temperature, the severe heat in summer—enough to make work very oppressive and fatiguing—and the extreme cold in winter are equalized by elaborate contrivances. It is a common device in American shops and restaurants to have fans attached to the roof for circulating fresh currents of air; but at the Juniata works there are ventilating machines, which pass the heated air in summer through ice as it enters the factory, and in winter, by an adaptation of the same contrivance, a current of heated air is sent through the factory. In this way the temperature is equalized all the year round, and the workmen can apply the same energy to their work in summer as in winter.

Passing through Johnstown, the scene of the disastrous flood, we approached the metropolis of the American Iron Industry, the city of Pittsburg. Everywhere in the neighborhood of the city was evidence of marvellous mineral wealth. The coal crops out on the flanks of the hills and the banks of the rivers. The seams are in many places ten feet thick and upwards, and the coal field is estimated to extend to an area of 1400 square miles. Petroleum rises from subterranean reservoirs and flows away in pipes to the refineries. The earth is tapped and natural gas springs from the soil, passing through pipes to feed boilers, furnaces, stoves, to warm shops and dwelling houses, to serve all industrial and domestic purposes, from driving an engine to cooking a dinner. With an unlimited and unrivalled supply of coal, iron, ready-made fuel and other natural agencies, Pittsburg could not help becoming a great industrial centre. Its geographical position as well as its natural richness is in its favor.

The State of Pennsylvania, of which Pittsburg is the leading manufacturing centre, produces 250,000 barrels of petroleum a month, has a yearly output of 30,000,000 tons of bituminous coal, and last year produced within a small fraction of one-half of all the pig iron and more than half of all the rolled iron and steel made in the country. This princely domain of 45,000 square miles, with all its boundless and marvellous mineral wealth, was ceded to the Penns by King Charles II. in satisfaction of a claim for £10,000.

The employers of Pittsburg are men who are directly engaged in the management of their own business. They struck me as being very much like English employers who have risen to the

head of establishments by their natural skill and aptitude for business. They are exceptionally active, energetic, full of push, resource, and enterprise, and are practical rather than scientific men. The life and activity of every one in the city, the extraordinary amount of production, the full employment of all the plant, and the whole conduct of industrial matters in Pittsburg, could not but impress every practical man with the opinion that Pittsburg is able to compete with any manufacturing city in the world. This activity, this continual work at high pressure, is characteristic of the whole industrial population, but what it costs it is not our province to inquire. But it strikes one with amazement that a population so fortunately circumstanced, enjoying unequalled natural advantages, with their natural gas and inexhaustible supply of coal and iron, with thousands of miles of water communication within their reach, and great railway systems radiating from their town, should be the leading advocates of protection for American manufactures. The State of Pennsylvania is the stronghold of protection, and the town of Pittsburg leads the State. To me this policy is difficult to understand. With such extraordinary advantages as these Pittsburg manufacturers possess, it appears to me that their industrial position is impregnable without the artificial barriers which they take so much pains to set up around them.

From Pittsburg the members of the Iron and Steel Institute went to the great city of the west—remarkarkable for its phenomenal commercial development—Chicago, where they experienced most sumptuous hospitality. We saw some of the finest buildings of America in Chicago. Such structures as the Auditorium and the Palmer House are notable for their architectural beauty and stately solidity. There has been a great development in the use of iron and steel for structural purposes in Chicago, and their application in the erection of fire-proof buildings is carried out on a very extensive scale. There are huge structures of sixteen stories in height made entirely of steel framework,—with an outside shell of terra cotta or other material, intended as an ornamental veneer, and not as a support to the building,—which is built on a solid substructure of steel beams and concrete. Little or no wood is used, so that these tall buildings are as fire-proof as it is possible to make them.

The method of handling corn in Chicago is much cheaper than the system adopted in this country, owing to the facilities afforded by the grading of wheat. Corn is stored in bulk in the granaries

or grain elevators, and classified by experts into grades according to the quality.

A farmer, when he delivers his wheat, receives in acknowledgment a corn certificate, certifying the quantity and grade of wheat received. The wheat is stored in grades, and the holder of the corn certificates—which in the meantime may have changed hands—can demand his wheat at any time. He does not receive the identical wheat given to the stores, but the same quantity of the same grade. Could a similar system of handling wheat be introduced into this country, instead of storing it in sacks?

The export of tin-plate from England and Wales to the United States is the one business which continues of great amount and value to Great Britain. It is a trade which hitherto the United States have not succeeded in withdrawing from us. It is one of the manufactures which it is the distinct object of the McKinley Bill to establish in America. The present business in tin plates with the United States amounts to $6\frac{1}{4}$ million boxes per annum, weighing about 400,000 tons. The duty paid under the old tariff is 1 cent per pound, or, say, £4 10s. per ton; under the new tariff it will be $2\frac{2}{10}$ cents per pound, or say £9 17s. per ton, so that the increased cost of duty on tin plates will amount to £2,140,000, and the total duty to £3,940,000. It is probable, therefore, that this duty, if maintained, will prejudicially affect our trade with the United States. There are projects to erect works there, but at present only small ones of an experimental nature are being erected. The fact is that many persons regard the prospects of continued protection as far from encouraging, inclining to the opinion that the result of the recent election is not only adverse to the McKinley tariff, but will accelerate the adoption of free trade. Should the duty on tin plates be maintained, the Americans will doubtless in course of time make their own tin plates; then the question is whether the farmers and the artisans of the United States will be content to pay a high price for canned goods and domestic utensils, for which tin plates are largely used, simply in order to put money into the pockets of a few manufacturers. Should the manufacture of plates be commenced there on a moderate scale, it will take many years to displace what we are now sending from this country, and in the meantime we can be looking out for other markets. Indeed, this question has lately occupied the serious attention of tin-plate manufacturers. Large quantities of cans might be used in China, Japan and India, for sending commo-

dities home which are now packed in thin sheet lead and wooden boxes. There are large districts in South Africa in which fruit of all kinds might be cultivated even better than in the United States, and we may look confidently to the South African and other colonies to compete with the United States in canned fruits. It is therefore wise not to be alarmed for the future tin-plate trade, but rather to anticipate with confidence that the United States trade will be replaced by demands from other markets, which will be opened by British skill and enterprise.

Our party divided at Chicago, one section going North to visit the iron ore districts of Michigan, Wisconsin and Minnesota, the copper mines of Lake Superior and the iron, copper and nickel mines of Canada, the other proceeding southwards to visit Alabama and other Southern States which are fast being opened up to new industries and becoming industrial rivals of the Northern States. I accompanied the Southern contingent. We travelled by night to Louisville, thence all day to Nashville, Tennessee, and arrived at Birmingham, Alabama, on the following evening. The rapid growth of the iron trade in Alabama is attributable to the close proximity and abundance of coal and iron ore rather than to any excellence in methods of mining or manufacture. Owing to these geological conditions, it is claimed, and apparently with reason, that the cheapest pig iron in the United States is produced here. As illustrating the vast and rapid expansion of the Southern States —a phenomenon which will have an important bearing on the commercial policy and future of the Republic—it may be interesting to note that Alabama produced 62,000 tons of iron in 1880, and 1,780,000 tons in 1890.

The colored population are largely employed as miners and as laborers about blast-furnaces and ironworks. They are cheap and slow. They are not as energetic or as regular as white men. To cope with their irregularities it is necessary to keep twice the staff for the same work. They are sluggish, and are quite content to earn a livelihood by working continually half-time. Their social wants are few. They live cheaply, often herding together in insanitary conditions. They do not act as foremen, nor are they often placed in responsible positions. White men must superintend and direct them. It is very noticeable how the white and colored population of the South keep absolutely distinct. There is no intermingling or social intercourse between them. The groups of women and children seen in the streets and at the railway stand

entirely apart. The white people apparently hold no communication with the blacks.

We were not long in finding out that the manufacturers of the South hold different opinions on fiscal questions from the people of Pennsylvania. In the Birmingham district the views of the people in favor of free trade are very pronounced. They expressed themselves as convinced that it was fortunate that the struggle for supremacy between the North and the South ended as it did in a victory for the North, but the Southerners are now as resolute in commerce as they were in arms, and strive against their Northern competitors for supremacy in trade and industry. They are confident that, with their abundant resources and the cheapness of production, they can hold their own with all competitors without the aid of protective duties. There is strong evidence that the Free Trade party in the South has extensive support, as this opinion was repeated in other places in Alabama, and also in Tennessee, Kentucky and West Virginia.

Leaving the State of Alabama, we reached the city of Chattanooga in Tennessee—the scene of the long struggle between the Northern forces under Grant and Sherman, and the Southern generals Johnston and Hood. We passed Sunday on Lookout Mountain, within sight of many battle-fields, and commanding a splendid view of the surrounding States of Tennessee, Alabama and Kentucky, extending as far as the Blue Mountains of North Carolina, more than 150 miles distant. But we could not linger among the attractions of the beautiful country. We were on our way to study an American city in process of rapid evolution—one of these sudden growths which are becoming as notable features of the South as they have been of the West—the town of Middlesborough in Kentucky. This new town, with a good English name, was all the more interesting to us because it is being developed by English capital. It is "run" by an English company, and is a model of systematic development on regular American methods. The town has been planned and laid out to accommodate a population of 200,000. All the institutions necessary for a commercial centre are being established. Middlesborough is already surrounded by a belt railway, with sidings from which roads will be continued to serve the different industries which it is understood are to spring up within and around the town. The first thing done in a foundation of an American town is to build an hotel; and here in Middlesborough we have a splendid hotel, capable of accommodating 200

guests, with all the requirement of a first-class house, built, equipped, lighted by electricity, and in full working order within twelve months. Lines of streets in the usual chess-board style are marked out, and house sites and corner lots bring high prices. A population of 7000 are busy building houses for the industrial population of the future. At the same time blast furnaces, rolling mills, and steel works are being erected. On the successful development of the iron and steel works the future of this community in a large measure depends. The members of the Iron and Steel Institute were amazed at the rapidity with which this new industrial city was being constructed, and much admired the boldness of the plans and the completeness with which the possibilities of the future had been anticipated.

From Middlesborough our tour led us through the Cumberland Gap, past the Great Outhurst mine and the Cripple Creek mines in Virginia, to one of the richest and most marvellous coal deposits in the world—the Pocahontas coal-field. This is a mountain of coal, discovered by explorers connected with a company in Philadelphia, and is now largely exploited by the West Virginia Development Company. The entrance to the mine is by a railway pierced direct into the mountain side, and worked by locomotive engines. We walked three-quarters of a mile on this railway into the mountain. The coal is mined on what is known as the room system—in rooms forty-five feet long and thirty feet wide. The railway wagons are run right into these rooms, and the coal is filled direct into the wagons. Large pillars of coal are left to support the roof. The seam is twelve feet thick and the inclination of the bed is one in a hundred, inclined upward. The Development Company owns at this one point to which we refer 300 square miles, which at the rate of 12,000 tons per acre, gives it a coal deposit of 2,304,000,000 tons. The miners are both colored and white. The latter are mostly Hungarians, of whom the superintendent speaks in the highest terms as to industry and sobriety. The manager of the works was trained in a coal-field in West Yorkshire. Pocahontas now turns out 4,000,000 tons of coal a year. It goes by rail to Norfolk and thence is shipped to New York and other parts. Atlantic liners sailing between New York and England use Pocahontas coal extensively. The extraordinary accessibility and abundance of coal in West Virginia will insure a supply of cheap fuel for ages to come. There is little doubt that a great manufacturing population will establish itself in this district, served by

the Norfolk and Western Railway system, which will be a strong industrial rival to Pittsburg and the manufacturing districts of Pennsylvania.

Continuing our journey towards New York, we passed through the Shenandoah Valley to Washington, where we were cordially received at the White House by President Harrison one day and afterwards by ex-President Cleveland at the Arlington House. From Washington we went to Baltimore, and were welcomed by the Governor of the State and the Mayor of the city. At Sparrow-point Works, on the Delaware, an interesting little object-lesson in protection was presented to us. The Pennsylvanian Steel Company established works here with the intention of bringing the ore from Cuba, but the Pittsburg Association of Ironmasters was powerful enough to get a duty imposed on iron ore which seriously hampered the operations of the Steel Company in their attempt to manufacture iron and steel from foreign ore. There cannot be a better illustration of the unwisdom of this policy of a nation deliberately shutting out cheap raw material which might otherwise give employment to American workmen and add to the economical development of American production.

New York was reached on October 28. We had travelled 4300 miles in three week and three days. Having visited numerous cities, traversed great regions of mineral wealth, passed through leading industrial centres, examined scores of mines, and inspected a multitude of works, we were everywhere impressed with the energy, the skill and the intelligence of the directors of the establishments engaged in the iron, steel, and collateral industries. While accomplishing our journey—travelling hundreds of miles by night and by day—we had an excellent opportunity of judging and enjoying the luxurious method of travel in America. We were whirled over States in palaces on wheels, with all the appurtenances of a city hotel adapted to the exigencies of locomotion. But the hurried and crude system of railway construction in America detracts considerably from the agreeableness of travel. The Pennsylvania Railway Company is just now making an experiment of three miles of road laid down in the English style. The defects in construction of American lines arise largely from the fact that a railway is often built for other purposes than the transport of passengers and merchandise. We hear frequently of the very low rates at which mineral, grain and goods are carried by American railways, but there is another side to the railway business in America. American

railways are very often laid down and equipped solely in the interests of land development companies. Capitalists who acquire land open up the new territory by building a railway through it, and as the object is the attraction of settlers, railway rates are fixed naturally very low. Hence those railways are not always commercially successful. Since 1875 there have been foreclosure sales of American lines of a total length of 50,525 miles, representing a nominal capital of 2,865,000,000 dollars; 2963 miles of railway were placed under receivers last year, and the nominal capital affected by this state of insolvency is 105,000,000 dollars. It may very well be asked, therefore, whether these low rates pay the railway companies.

In the course of our tour we came in contact with the managers of many industrial establishments, and could not help remarking their youth. Evidently skill and managing capacity are more speedily recognized in young men in America than in England, and young men by their energy make their way sooner to responsible positions. I cannot avoid observing here that men so competent to develop and manage the great American industries are certain to be fully alive to the value of every deposit of mineral, and quick to seize every opportunity for commercial advantage; and therefore it cannot but be reasonable to offer a word of counsel to those who are invited to interest themselves by investment of capital in American commercial undertakings. Surely the men who are so energetic and competent to manage these adventures which have achieved great success are not likely to sacrifice their opportunities when they permit the property to be transferred into English hands.

The special features of the iron and steel industry in America have been indicated; what, it may be asked, are the leading characteristics of those engaged in the work? I would answer, their quickness to adopt improvements, and their readiness to adopt scientific methods in the process of manufacture. Great as has been the industrial growth of America, marvellous as are the mechanical achievements of Americans, we can still claim that the inventions which have brought the manufacture of iron and steel to its present state of perfection are of English origin. The Americans have not invented, they have improved. They had not time to experiment, they have appropriated. They possess a surprising gift of receptivity, and a peculiar faculty for adaptation. When the great development in American manufacture took place, Americans

engaged in the iron and steel trade had the best practice and the best methods of Europe before them. They were never handicapped by preliminary experiment. Special commissioners on behalf of the leading American ironmasters examined the Bessemer process after it had been established in England. After inquiry they profited by English experience. Thus many mistakes were avoided and much time saved. With this knowledge, supplemented by their own ingenuity for mechanical devices and appliances, they were able to lay down plant of the best models, and of great strength and capacity, so that their Bessemer plant compares favorably with any to be found in Europe. Their blast furnaces are more capacious than ours, their engines are more powerful, their rolling mills are of new and improved construction. The high standard of education, and especially of the technical education, of the people in America undoubtedly is much to their advantage, and we everywhere recognized a promptness to discard old methods and plant, and an alertness to adapt the newest and most scientific methods of production.

Many of the great iron and steel works in England, profiting also by their international experience, are laying down new plant on a large scale, and there is no fear but that, on equal terms, the English iron and steel makers will continue to hold their position with their keenest competitors. It is true that in the United States in 1889 the production of pig-iron for the first time exceeded the production in Great Britain. Nine millions two hundred and two thousand tons was the product of the United States, against seven millions eight hundred and seventy-five thousand of Great Britain. The increase in the American output arises from the development of the Southern States, and the whole of this great production has been consumed in the United States, which now possesses a railway system of 160,000 miles in extent. In addition to this, iron is being very extensively adopted in the cities for structural purposes for houses, warehouses, public buildings, bridges, etc. In New York and some of the great cities it is supplanting stone and wood construction, which is diminishing because of the cost of transport and the scarcity of timber. Iron will more and more be used for structural purposes in America, and it is clear that the resources of the United States, vast as they are, will find their market on the American continent. There need be no ground for apprehension as to the competition of the United States. Our insular position, our abundant supply of labor, our accessibility to mineral products, make it

certain that England, as a producer of iron and steel, will continue to hold the leading place in the neutral markets of the world. When America foregoes her system of protection, which cramps her development and limits her intercourse with foreign nations, it is certain that her increased prosperity will have a favorable effect on the industries of this country.

Our visit was ended in New York, where, after a short excursion to Niagara, the hosts who had welcomed us on our arrival again showered upon us a hospitality as rich as their own boundless resources, and as large as their continent. These expeditions, through which we meet eye to eye and voice to voice our friendly competitors to discuss the interests and the scientific aspects of the great industry which absorbs us, have been of great personal and national benefit. It is thus we learn how much has been accomplished by persistent and intelligent labor, how much remains to be achieved, and how by free exchange of ideas and of productions, friendly understanding is promoted and personal acquaintance is built up.—**Contemporary Review.*

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THE TAP-ROOT OF INDUSTRIAL DISCONTENT.

By Hugh O. Pentecost.

THE dullest observer has probably noticed that there is disturbance in the relations between employers and employés. Strikes and lock-outs are of frequent occurrence. In Europe, in Pennsylvania, in Colorado, within the past few weeks, human blood, in not inconsiderable quantities has been shed in conflicts between those who are presumed to represent law and order and those who were contending for what they believe are or should be their rights. Capitalists are strongly and generally secretly organized against the efforts of working people to minify their profits. Working people are more loosely, openly, and not so powerfully organized to prevent an increased appropriation of the products of their labor by their employers or, to put it differently, to augment their earnings.

It will be observed by the careful onlooker that the contending parties are being more and more sharply defined into employers, bankers, professional men and political rulers on the one side and wage-earners on the other ; and that the intervals of time between violent outbreaks, usually described as riots, grows shorter. So evident is this latter fact that General Albert Ordway, commander of the militia of the District of Columbia, recently warned the officers under his command to prepare for events in the immediate future more awful to contemplate than the so-called riots of 1877 were in reality.

Whatever may be the direction of our sympathies, whoever may be supposed to be to blame for the condition which confronts us, the substantial if not the exact accuracy of the statements made in the foregoing paragraphs will probably not be denied.

For the purposes of this paper it is not necessary to attempt to fix blame for the situation upon any class of persons. Strong arguments are constructed to show that the persons who are called, in general, capitalists are responsible for the situation by what is passionately called their unjust oppression of wage-earners ; and equally strong reasons may be adduced to demonstrate that the persons who are called, in general, laborers are the authors of whatever misfortunes they may be suffering. But the careful student of the

history of the formation and development of what we commonly call society will probably regard time employed in the study of personal motives and the quality of personal acts in connection with the present social condition as worse than wasted. Society as it is, with all its splendor and all its misery, all its wealth and all its poverty, all its exaltation and all its degradation, is the natural sequel to all that has gone before. When we know what has been it is very difficult to understand how we could have escaped what is. It will be more satisfactory, therefore, to waste no effort in attempting to fix blame for a perfectly natural condition, but rather to lend ourselves to the task of attempting to understand that condition, and learn how it may and perhaps will be changed for the better.

It must suffice here to call attention to but one factor of the problem, which, while it is by no means the only, is, nevertheless, the most important from a purely economic standpoint. This factor is *the monopoly—the holding out of use—of vacant land.*

If this statement appears dogmatic, it must be remembered that there is no opportunity here to furnish the scientific proofs of it. It should, however, be easy to comprehend its truth after considering the situation from a practical standpoint. Any one should be able to see that a mere laborer, with no possessions other than his ability to work, is fatally handicapped by the single fact that he has no place to sleep and no shelter from the weather, without paying some landlord for such benefits, and that he has no opportunity to get food without finding an employer who will pay him for his labor. In other words, a penniless laborer is wholly dependent for his life on an employer, for the reason that he is not in possession of land on which he might provide himself with shelter and food. Land being as much a necessity of life as air and water, if it is monopolized, those who do not possess it are industrially at the mercy of those who do, and of those who are advantageously placed by reason of their social or political affiliation with vacant-land owners.

The monopoly of land consists in the exclusive control of land not in use. The occupation and use of land—call it "possession" or "ownership," as you like—is not a social injury ; but the exclusive control of land not in use, the dog-in-the-manger ownership of land, so to speak, is the greatest of all social injuries. Such tenure of land must cease before involuntary poverty will disappear, before human freedom will be realized, before social harmony will appear in place of the present era of social disturbance.

Let us draw some illustrations from current events. In Pennsylvania recently there have been scenes of bloodshed in connection with the great strike in the coke region. This bloodshed was occasioned by the fact that a number of men with no opportunity to support themselves were fighting for a chance to be employed, at living rates of wages, by certain owners of mines and furnaces.

The region in Pennsylvania, which was the scene of this disturbance, is specially characterized by the richness of its coal deposits. Vast stretches of territory, extending in almost every direction, are underlaid with deposits of coal sufficient in quantity to supply every possible demand for centuries to come. Here and there an opening in these deposits has been made and is industriously worked, but in the main this vast mass of raw material is held securely in the hands of the companies who are operating the few mines that have been opened, and the privilege of unearthing it is held at so high a price that it is practically prohibitive. Indeed, it is a fixed policy among successful mine operators to secure the control of coal deposits liable to come into competition with them for the double purpose of commanding a higher price for the product of mines that have been opened, and of keeping down the wages of the limited number of miners employed. Suppose that these limitless opportunities for labor were open to the use of miners who are discontented with the wages now paid by their employers. Would there have been any likelihood of such violence as we have seen? Would not the discontented miners have quietly turned to the use of the opportunities about them?

So, if we turn to the recent house-smiths' and carpenters' strikes in this city, the same remarks apply with equal force. If all the unused building sites in New York City and throughout its numerous suburbs, which are now held out of use by speculative investors, were open to the free occupancy of those who desired to use them; or in other words, if it were unlawful or disreputable to hold land out of use for speculative purposes, does any sane person believe that there would be any lack of demand for house-smiths and carpenters to build homes for the thousands who are rich enough to build, but not rich enough to also pay monopoly prices for land? Would such a "strike" be possible under such conditions?

Following the idea further, suppose that each one of these discontented workingmen had been in possession of a plot of land large enough to enable him to support his life. In that case he would have been in a position to demand wages equal, at least, to

what he could produce by applying all his labor to his land, and if he could not get such wages he would have gone quietly about his business, and there would have been no social disturbance or fighting; and, too, there would have been no stagnation in trade, for each man would have continued to produce wealth equal in quantity to what he had been producing, and the processes of exchange would have gone on.

I am not a believer in patent social panaceas. I believe that individuals must become better educated as to how it is wise to live in social relations before the world can be improved. Social improvement will only come about by the evolution of individuals, the general diffusion of knowledge as to what is necessary to human welfare. But it is clear to me that a necessary part of such individual education is to know that industrial discontent will prevail as long as it is permitted for certain men to hold a large part of the earth out of use to the exclusion of other men who would, if they were allowed, put the now vacant earth to productive use. It is this privilege to hold land out of use which gives employers their chief advantage over workingmen, and as long as workingmen suffer such a disadvantage, they will be poor, discontented, and, at times, violent. Nor can they be rationally blamed for their discontent, for they know that in the distribution of wealth they do not get what represents their fair share of the wealth produced. Very few working people understand *why* this is so, but they understand that it *is* so, and it is this that keeps them discontented and turns them into strikers and sometimes rioters. They "bark up the wrong tree," in fighting their employers, for they do not know where the right tree is, but they know they have a real reason for barking, and it should not be surprising if they occasionally bite, and bite the wrong person, that is, the person who is not the real cause of their troubles.

In the nature of things, the labor organizations are no match for the power bestowed on employers by the privilege of monopolizing vacant land—the right to close natural opportunities for labor. The land monopoly clothes employers with the power of a lion. Laborers are like a small pugnacious animal in the power of that lion. Strikes and boycotts are like the slight scratches and bites of the small animal, which may make the lion's feast less comfortable than it would be if he were dealing with a lamb, but they by no means prevent the lion from making a meal off his victim. Nor can mere trades-unionism ever be a remedy for indus-

trial discontent. It is merely an expression of that discontent; a blind protest against oppression felt but not understood.

If we consider the schemes of the economical reformers we shall find most of them also inadequate to relieve the situation.

Henry George's single-tax proposition, for example, which at one time appeared to many persons as an evangel of redemption, would leave land monopoly undisturbed, except that if it could be put into operation it would transfer sixty or ninety per cent. of the legal appropriations of the owners of land, as such, to the public treasury, to be expended in public works or personally appropriated by the politicians in office. It would leave the laborer still at the mercy of the employer, and, hence, still discontented.

Socialism would indeed put an end to private land monopolies, but not to land monopoly as an institution. It would merely transfer all land to the control of the persons in political offices. The essence of socialism is the purpose to have all the people of a given locality, instead of a few, benefit by the monopoly of land. It does not purpose to have land monopoly cease.

Nationalism, or Bellamyism, as it is sometimes called, is not a scheme for abolishing land monopoly, but for making the nation the giant landlord.

The Farmers' Alliance merely wishes to create new monopolies by which farmers and certain other property owners may enjoy privileges they do not now have. It pays no particular attention to the land question.

All of these economic schemes are worthy of attention, for they theoretically possess certain financial advantages to a large number of persons over the present economical system, although those advantages in my opinion would be over-balanced by certain dangers to individual liberty which it is best to avoid. But they are all fatally defective, in that they count on retaining in some form that greatest foe of human liberty, property in vacant land. Nationalism (a form of socialism) would unquestionably abolish poverty, but it would be on the principle employed at Sing Sing—at the expense of personal liberty; and, if I am not mistaken, most persons would rather be poor and free than wealthy and in political and industrial bondage. Hence nationalism would not abolish industrial discontent.

The only idea of social change which any intelligent people will finally entertain I think, will be one which contemplates a fairer distribution of wealth coincidently with an even larger measure of

individual liberty than we now enjoy. Such an idea is that of the cessation of property in vacant land, followed by or coeval with the cessation of monopolies of all kinds.

The reader to whom this proposition is new may ask many questions regarding it which cannot be answered in a magazine article. I have been obliged to confine myself to the bare statement of the proposition, not having space in which to marshal the evidences of or argue for its correctness; but any clear thinker will need little more than the foregoing meagre statement of the proposition to enable him to discover its logical soundness.

To the question: How can such freedom of vacant land be brought about? I have to answer: There is but one way. It cannot be voted or legislated into being, for it would be impossible to legally define what is and what is not vacant land. It cannot be accomplished by the will of a majority, for reasons involved in the statement made in the foregoing sentence. It is useless then to even think of forming a political party to effect it, although it might be possible to approach it politically. For example: Laws might be made extending something like the power of eminent domain to individuals; by virtue of which a landless person might have vacant land condemned to his use on payment to the legal owner of a fair price, based on the present actual value, not the future speculative value at which vacant land is always held. Such an arrangement, however, would be useful principally by way of education, or as what "practical" persons are wont to call an "entering wedge." I do not recommend it, but merely suggest it as a possible "practical" approach toward freedom of vacant land.

And if free vacant land cannot be voted, or legislated, neither can it be shot into being by powder and bullets. It is folly, therefore, to even think of forceful revolution to accomplish it. It can only be reached by familiarizing the people with the idea, and getting them to understand the desirability of putting it into practice and to so wish for it that it shall become as disgraceful to hold land out of use as it now is to steal a spoon from the table of one's host.

No proposal to legally or forcibly deprive present or future owners of their titles to vacant land can be rationally entertained, for however injurious to the vast majority of the human race those titles are, their present owners came into possession of them by methods recognized as fair and respectable, that is to say, by the consent of the people from generation to generation. They cannot,

therefore, be fairly deprived of them without their consent. Land monopoly should not be abolished. It should disappear by wearing away, as all moribund social injuries have, in the last analysis of the process, disappeared. It has grown naturally. It should die naturally. Indeed, it can die in no other way. It rests upon ideas. It can only disappear with the ideas on which it rests.

To all of which it may be replied that if this is true, it will be a long time before vacant land will be free. Perhaps. Evolution is slow. But with this we may as well be content, for although industrial discontent will not disappear until vacant land is free. vacant land will not be free until public opinion demands it and visits on the vacant-land owner the social ostracism which now falls on the professional criminal. Public opinion forms slowly, but it does form, and it has a tendency to form in beneficial directions. Countless ages passed before a despotic ruler became impossible in a few nations, before a waiter in a restaurant was allowed to dress exactly as the most socially exalted person in a nation, but the time for these things finally came. And so may the time come when an owner of vacant land will be as disreputable as the owner of a chattel slave would be in some parts of this country to-day. If that time comes men will no longer seek to hold as much land as possible out of use for speculative purposes, but will desire only so much land as is necessary for the prosecution of their productive business. They will no more need a law to define or compel them to surrender vacant land than persons in good society now need a law to prevent them from pilfering jewelry or table ware from the house of a friend. If industrious men are to be sure of being comfortably well off, and personally free, it will be when none shall possess more land than he will himself productively use or employ others to use for him ; it will be when it is so that any person may apply his labor to any land not already in use. To put it into a phrase: To insure a fair distribution of wealth and personal freedom, land must be held only by occupancy and use. The moment a person no longer wishes to use land he must abandon it to the next comer, who shall be allowed to occupy and use it without let or hindrance by any one.

It was a great day when the steam-engine came into the world. It was the beginning of the era of inventive power. We are living in it not knowing what a day may (or may not) bring forth.

The steam-engine was the natural outcome of many iron-working arts; some of great antiquity, some almost its contemporaries. Less than a century and a quarter ago it became a successful and permanent machine applied to the working of furnaces, mines and mills. In this country we have now had eighty-four years of practical operation of steamboats, sixty-two of railroads, and about fifty of regular ocean navigation.

The census of 1880 recorded about 254,000 manufacturing establishments, representing over two thousand eight hundred millions of invested capital, employing nearly two and three quarters millions of operatives, paying annual wages of nine hundred and fifty millions, utilizing material valued at three thousand four hundred millions, and producing merchandise worth nearly five thousand three hundred millions of dollars annually.

To produce this there were employed about three and a half millions of horse power, of which two-thirds were contributed by the steam-engine.

What the census of 1890 will determine we do not fully know; but it is a significant fact that the two cities of New York and Philadelphia which in 1880 reported manufactures to the value of eight hundred millions of dollars, now claim for the year 1890 a product of one thousand four hundred and fifty-eight millions, with Philadelphia fifty-eight millions to the fore.

It would be wearisome in the extreme to trace the progress of the steam-engine through every department of its usefulness. It

is sufficient for the most part to suggest to the well-informed a hasty consideration of the processes of production and manufacture.

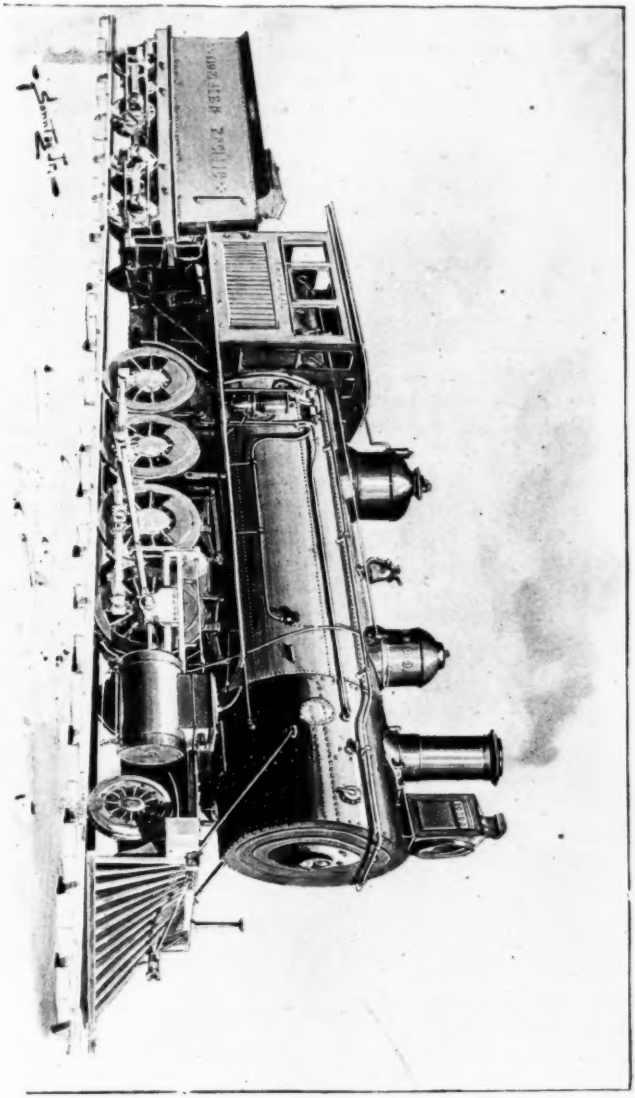
Think of the mills and factories for things rolled, drawn, welded, and riveted; for the things crushed, ground, mixed and pulverized; for the things spun, knitted, woven and wound; for the things hammered, punched, pressed and stamped. Think of the things sawed, planed, turned, smoothed, polished and sharpened; of the things hoisted, lowered, excavated, handled and carried; of the things blown, fanned, exhausted, pumped and compressed. Think of the things plastic which are moulded and squeezed into shape; think of the secondary powers—pneumatic, hydraulic and electric; and when the mind has had time to recover its balance, give a passing thought to the work of the printer.

Does it give any adequate idea of the power involved to know that this country produced in 1890 more than seventeen millions of tons of iron ore, more than ten millions of tons of pig iron, nearly four and a half millions of tons of steel, nearly thirty-six millions of tons of anthracite, and one hundred and fifty millions of tons of bituminous coal?

Can we conceive the magnitude of a railroad system of two hundred thousands of miles of tracks, over which six hundred and twenty millions of tons of freight and four hundred and ninety five millions of people passed in 1889? Possibly it may help us to know that more than twenty three thousand passenger cars, more than one million freight cars, and more than thirty-one thousand locomotives were required to do the work; and that the cost of this vast system and its accessories has been upwards of eight and a half billions of dollars.

Does it occur to us as we pass swiftly from city to city and from ocean to ocean, that if it were possible for this stupendous web of the giant spider, steam, to disappear with its creator in a night, the world would wake to ruin and desolation in the morning? Do we recognize that these millions of wheels would stop? that the two millions of registered steam tonnage of our merchant marine, and the nine millions of foreign steam tonnage calling at our ports would be powerless to move the products of the earth and the mill? and that our commerce of sixty billions of dollars would shrink and dwindle away?

Fortunately for us no such catastrophe is likely to occur; and we may go on extending our shipping, our railroads, our mills,



EIGHT-WHEEL HEAVY FREIGHT LOCOMOTIVE—N. P. R. R.

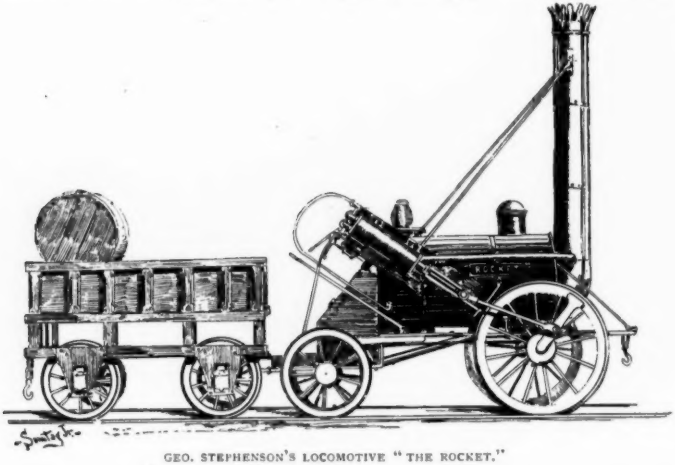
mines and farms, safe in the power to provide for our sixty-two millions of people and for the hundreds of thousands of strangers who yearly come to our shores.

It is but just to the first great cause of our prosperity, to the steam-engine, the prime mover of the modern world, that we, its beneficiaries, should be mindful of its deeds, grateful for its benefactions, and grateful to those who are its guardians and helpers. It is but just that we take interest in the ingenious shapes it has taken unto itself, in the evolution which has almost magically taken place.

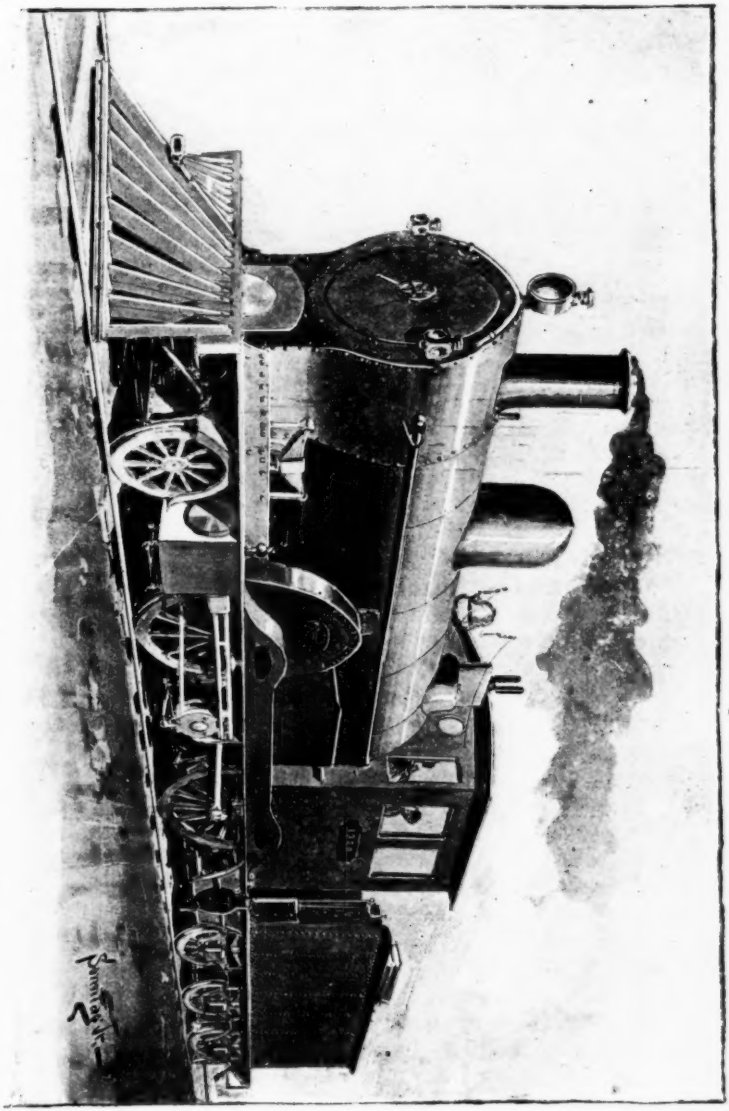
From Ericsson's locomotive of 1829, weighing 2½ tons, or Stephenson's "Rocket," to a high speed passenger locomotive with 78″ drivers, weighing over 58 tons, or to a "Decapod" weighing nearly 100 tons, is a long step; but it is not longer than the stride from John Fitch's "first double-acting steamboat engine, with condenser, transmitting power by means of cranks," to the 17,000 horse power triple-expansion engines of the *Teutonic*, or the 20,000 horse power engines of the *City of Paris*.

Nor is it a longer step than from the first direct-acting steam pumping-engine to the high duty water-works engine 125 feet high, or to one which pumps to the sea-board 25,000 barrels of petroleum per 24 hours, against a pressure of 1500 pounds per square inch.

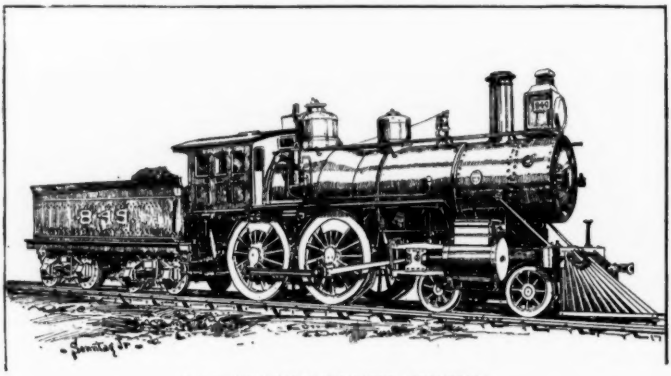
It seems superfluous to dwell upon the services of the locomotive and the steamship. They are always with us. We all



GEO. STEPHENSON'S LOCOMOTIVE "THE ROCKET."



F. W. WEBB'S IMPROVED COMPOUND LOCOMOTIVE.

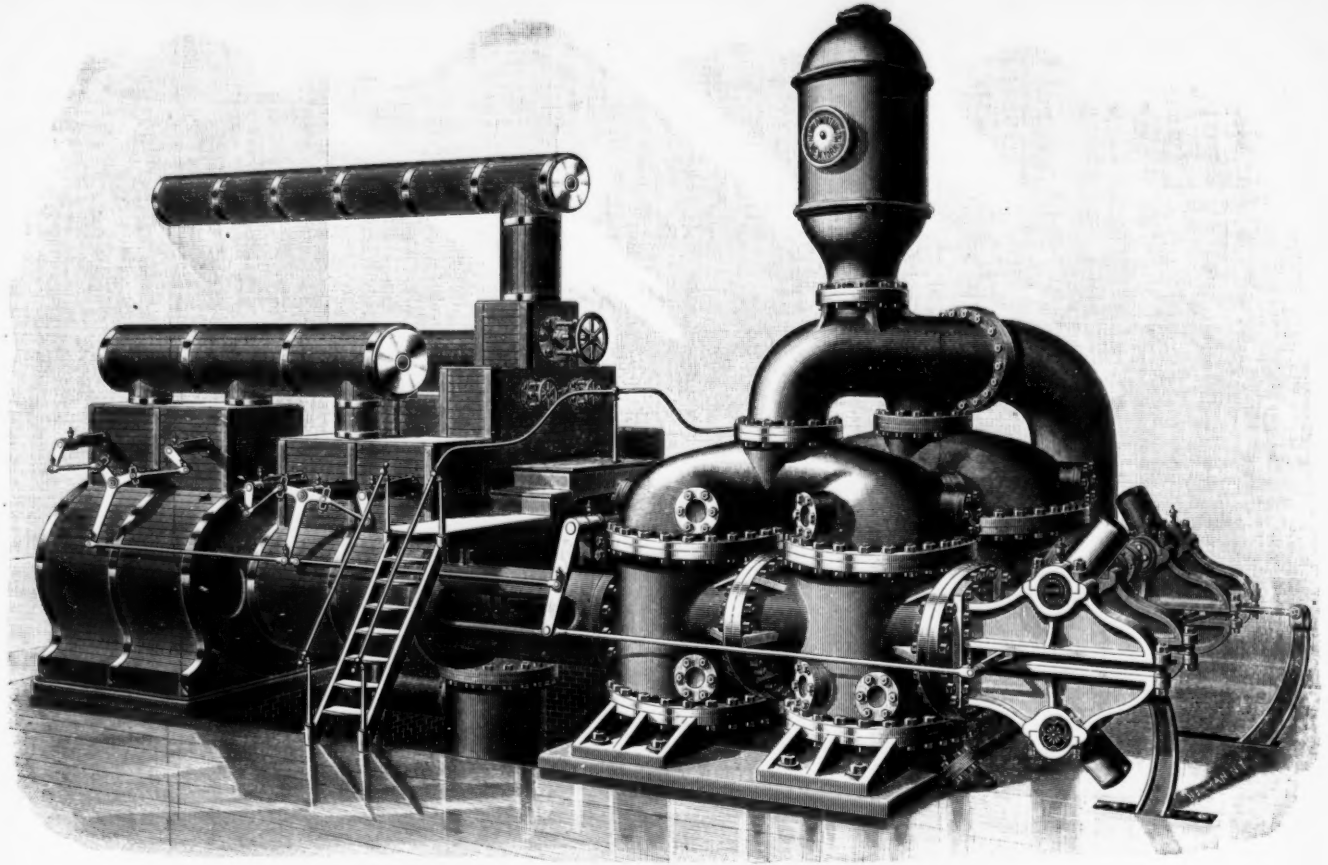


B. & O. HIGH SPEED PASSENGER LOCOMOTIVE.

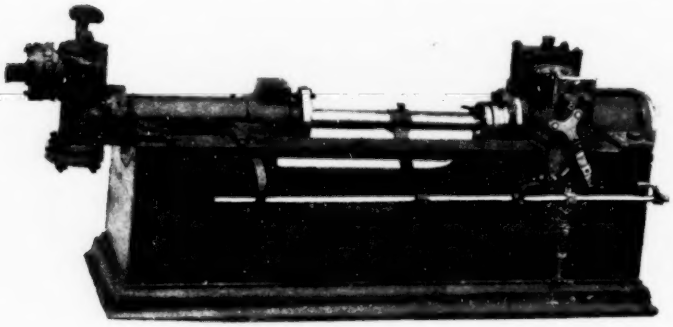
know not only how indispensable they are in commercial affairs but how with every hour which disappears from the time table and every fraction of a day saved in the voyage and the post, the scheme of the world grows plainer and the difference in peoples and races grow less. It all helps us to recognize and allow for different points of view.

We all know what the locomotive looks like, but we all may not have seen, or may not have remarked if we saw, the exponent of advanced practice in recent motive power—the compound locomotive. While our locomotives of the familiar type have been efficient, they have not been economical. They have been consuming on the average six pounds of coal per horse power per hour. The compound locomotive, like other compound engines, takes the exhaust as it comes from the first or high-pressure cylinder and expands it a second time in the low-pressure cylinder.

In steamship service the steam-engine has reached its greatest present development. There are no engines in land service so powerful as those of the *City of Paris* or the *Teutonic*. There are probably none more economical. The coal consumption of the *Teutonic* is given as about 320 tons in twenty-four hours, under an approximate development of seventeen thousand horse power. She has two pairs of triple-expansion engines, with cylinders 43″, 68″ and 110″ diameter by 60″ stroke, working under a steam pressure of 180 pounds at the high-pressure cylinder. She has an engine-room staff of 168 men. The pumps which feed her boilers absorb 120 indicated horse power. She has made a voyage of 2806



THE HIGH-DUTY PUMPING ENGINE AT THE 68TH STREET PUMPING STATION, CHICAGO.
Capacity at 130 feet piston speed, 16,000,000 gallons in 24 hours; duty obtained at 100 feet piston speed, 118,000,000 foot pounds on coal fed to boilers.



THE FIRST DIRECT-ACTING PUMP.

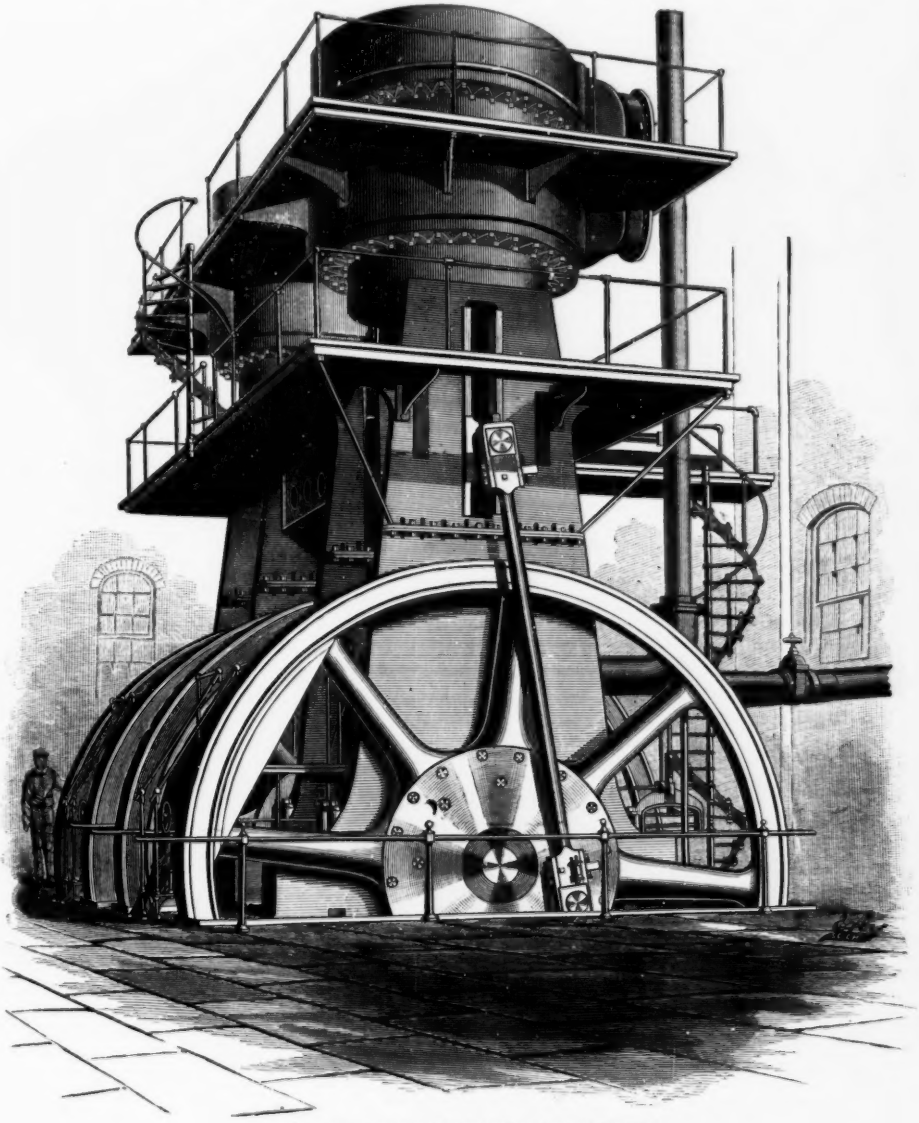
knots in five days, nineteen hours and five minutes, at an average speed of 20.18 knots, or 23¼ land miles per hour.

Possibly the services of a steam pumping-engine to civilization may not seem great. Let us consider a moment. The foundations of great cities are not laid with reference to future water supply but with reference to commercial advantages. At the beginning the well and hand-pump suffice for village and town supply. But there comes a time when the increase of death-rate is rightly attributed to contamination of drinking water and pure water in large quantities must be brought from a new source. In seventy cases out of every hundred, experience in this country has shown the conditions to be against a gravity system and in favor of pumps, which have been adopted.

Our water-works guard the life and health of over fifteen millions of people. More than thirteen hundred water-works were operated by steam-engines in 1890, and the combined capacity of the pumps was in excess of four billions of gallons in twenty-four hours—equivalent to a lake two miles long, one mile wide, and ten feet deep. Sixty per cent. of these water-works have been built since 1880.

Cities of enormous population, like New York, may be able to afford an aqueduct driven through thirty miles of solid rock, but they are few. And even New York is dependent upon the pumping engine for high service distribution and for the working of its elaborate system of hydraulic elevators.

And again we who dwell in cities and towns are almost absolutely dependent upon the steam pumping-engine for protection



A PAIR OF BLAST FURNACE VERTICAL BLOWING ENGINES.

Record : 419 tons of iron in 24 hours ; 2161 tons in one week ; 8398 tons in one month.

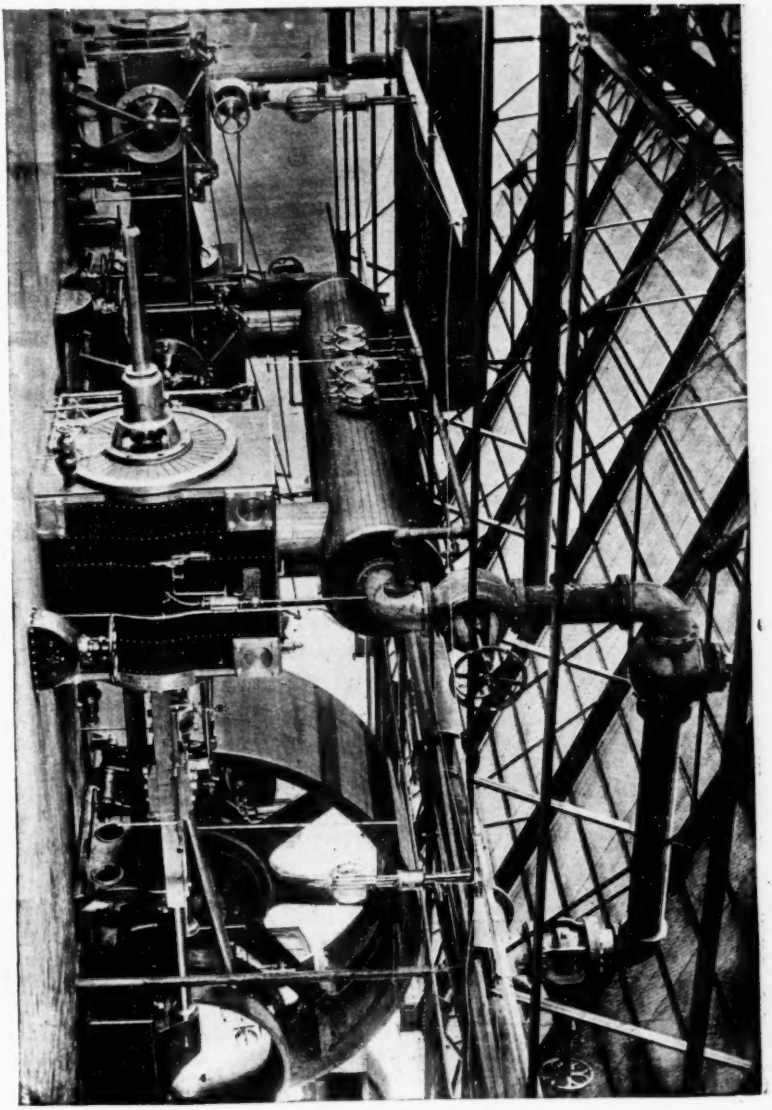
against fire, while those who do not dwell in cities and towns are almost absolutely helpless against fire, being without it. We are also in many cases dependent upon it for the pumping of large volumes of sewage which we would not otherwise know how to get rid of.

Looking down upon New York from the Brooklyn Bridge or the *World* building, every one would be impressed by the number of jets of steam to be seen escaping into the air. There are known to be 2500 steam plants in the city and the large majority exhaust into the atmosphere. Energy and heat are entirely wasted by the free escape, and more than this, there is the water. Even if we have only 50,000 horse power exhausting into the air and the engines average thirty (or more) pounds of feed-water per horse power per hour, or four gallons in even figures, this means 2,000,000 gallons, or at least $400 worth of pure water, paid for in coin of the realm, wasted and thrown away every day.

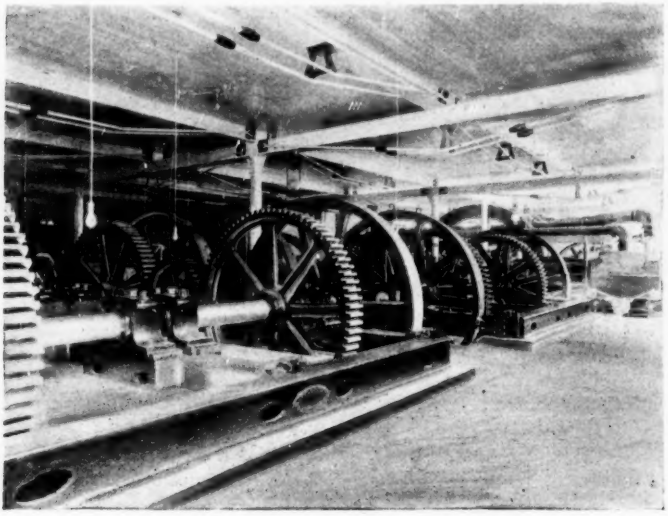
For a long time the exhaust of engines has been utilized in winter for the heating of factories; it has also been employed for steaming, drying, heating feed-water and the like. When used for heating purposes the condensed steam is generally returned to the boiler and used over again. But of recent years the use of the exhaust has attracted still further attention. One of the most interesting and novel economies connected with the exhaust is the manufacture of ice. A 300 horse power engine consumes approximately 100 net tons of steam in 24 hours. When this steam is condensed, skimmed, filtered and frozen by means of anhydrous ammonia, the net result is about 60 tons of beautifully clear, pure ice, produced at a very low cost.

The advantages of ice-making in this way are at once apparent. If made in the city where water costs money, the water which is paid for as steam is sold as ice. The ice is made from day to day as it is required. There is no large investment for storage houses, and the meltage is reduced to a minimum. The ice is made where it is to be consumed. Transportation charges are avoided. A single 25 feet by 100 feet city building is more than large enough for a plant of 60 tons daily capacity.

Another economy from which very good results are claimed, is being practised in several places in connection with electric light work. The companies sell their exhaust steam for heating purposes on the same basis as a steam heating company. It has been found practicable and economical to deliver the exhaust to a steam



1000 H. P. REYNOLDS-CORLISS TRIPLE-EXPANSION ENGINE AT THE NARRAGANSETT ELECTRIC LIGHT STATION, PROVIDENCE, R. I.

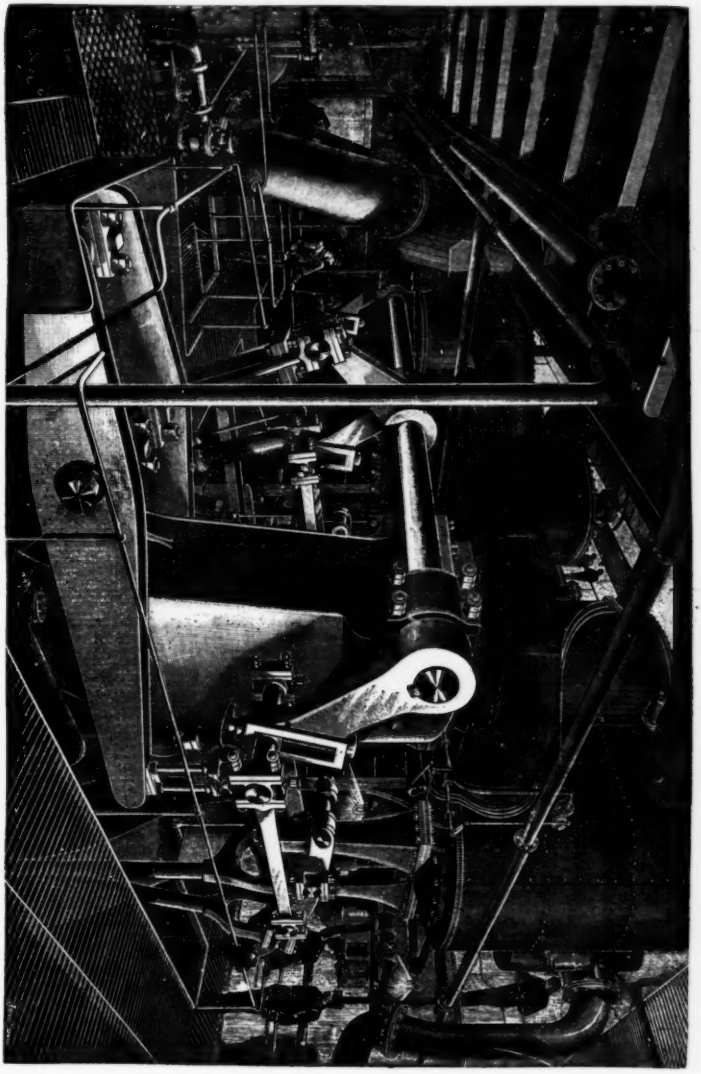


POWER HOUSE INTERIOR—DENVER CABLE RAILWAY.

system under a very considerable back pressure, amounting even to 60 pounds or more, if required, for power as well as heating purposes.

In this connection it may be interesting to mention that it has apparently been clearly established in the case of certain mills of Amoskeag, N. H., and Lawrence, Mass., which have both steam and water power plants, that when a water rental representing a fair return on the cost of water rights and improvements is charged, water power may not be as cheap as steam if conditions favorable to the utilization of the exhaust prevail. Indeed it is stated that in the Amoskeag Mills where large quantities of live steam are used in dyeing, when the engines of 1200 horse power are run under a pressure of one hundred pounds, and the exhaust delivered to the dye-houses against a back pressure of 10 pounds, no increase of fuel is noticed in the boiler-house over and above the daily fluctuations commonly observed when running with water power and using live steam in the dye-houses. This is the paradox now familiar in steam engineering as 1200 horse power for nothing.

The future of the steam-engine points to consolidation just as the future of other business does. We have many engines which



STEAMSHIP TEUTONIC—STARBOARD ENGINES, MIDDLE PLATFORM, FROM FORWARD STARBOARD CORNER.

require five pounds and over of coal per horse power per hour. Three pounds is very good economy with the improved forms of high pressure engines. Now it is clear that a multiple-cylinder condensing engine located on the river bank and using not to exceed a pound and a half of coal, and saving the water where the feed has to be paid for, affords an opportunity for commercial profit in the supply of power—adequate means of transmission only being required.

There are two such means in view—electricity and compressed air. Both are in use and are likely, with increased economy in the means of transmission, to be very widely extended.

The compressed air company in Paris has two stations now running, aggregating 2500 horse power, with a third station building. The new station is designed ultimately to contain 24,000 horse power. Four vertical triple expansion condensing engines of 2000 horse power each are under construction. The guarantee of the engine builders is 1.54 pounds of coal per horse power per hour. The compressed air is chiefly used in driving small motors and in package transmission.

But the transmission of power by electricity and compressed air has a wider field than this. Both methods are exceedingly important factors at the present time in the mining world, and while in many cases water power is the generator, yet the steam-engine is the prime mover of the modern world in this as in other cases. Our tunnels, our quarries and mines are driven and worked by rock drills actuated by steam, compressed air, and electricity. We have electric haulage, tailrope haulage, electric and compressed air locomotives, and electric and compressed air coal-mining machines. We have electric hoisting engines and electric pumps, but more than all we have the electric light. And no one who passes from the faintly mitigated gloom of the gas-lit street to the reassuring gleam of the arc light can fail to call it blessed.

There are now fourteen hundred or more public electric lighting stations in the United States, with engines probably aggregating 400,000 horse power. The private lighting equipment of the country is even larger than the public, and it is within the facts to say that we have one million horse power running upon electric work to-day.

The electric railway is one of our infant industries also, but that it is a promising infant Mr. Sprague's statement of its growth in four years from nothing to a system of 325 roads operating 4000

cars on 2600 miles of tracks and carrying 750,000 passengers in the year, will go to show. It is probable that in the neighborhood of 150,000 horse power is required to operate these roads, and it is regarded as one of the most trying kinds of work any engine is called upon to do. The fluctuations are instantaneous, and frequently range from nothing to the maximum power of the engine.

To the electric light and the electric railway belong the credit of developing the high speed stationary engine. It has been designed to drive dynamos by belt directly from the engine fly-wheel, and the speeds vary according to size and design from 150 to 450 revolutions per minute. Such an engine is required not to vary more than from two to two and a half per cent. in speed in changing from light to full load ; and it is designed to develop its power with economy of space, metal, and foundations. High speed engines are built in all ways, high pressure, compound, compound condensing, triple and triple condensing. Guarantees of economy are made as low as 28 pounds of feed-water per horse power per hour for high pressure engines, 18 pounds for compound condensing, and $14\frac{1}{2}$ pounds for triple condensing, under suitable conditions of pressure, speed and load.

Opinions of electrical engineers upon the subject of engines have undergone a process of evolution along with their practice. There has been and still is much controversy on high speed *vs.* slow speed; and engines of all sorts and kinds are to be found in operation and are apt to be spoken of with equal praise by the engineers. But as a rule the heavier and more regular the load the larger are the engine units and the more likely is the Corliss engine or one of its slow or moderate speed competitors to be chosen. Conditions of economy, however, are directing practice strongly towards the use of the multiple-cylinder engines, preferably condensing ; and the high cost of real estate in cities is inclining it to vertical engines, which already are in high favor in Europe.

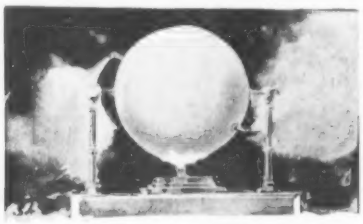
Plants in electric lighting work frequently range from one thousand to five thousand horse power. One lighting station in New York City is designed ultimately to contain twenty thousand horse power, and one railway station in Boston is being prepared for thirteen thousand.

The installations for cable railways have been in marked contrast to those for electric work. A cable plant is put in once for all ; the electric plant is elastic and may be extended almost indefinitely. Permanence, safety, and economy of running have there-

fore been the first considerations in cable work. The engines are selected for their substantial build and high economy. The cable drums are operated either by gearing or by rope transmission.

The extension of cable railroads has been retarded by the extreme first cost, but the consensus of opinion seems to be that it is the cheapest way of handling heavy traffic on surface roads.

There are many departments of steam engineering which should be noticed to make this article complete. But it must remain incomplete. Is not a mill covering 15 acres of floor space, with an engine of two thousand horse power which revolves its ponderous wheel of thirty-two feet diameter weighing one hundred tons, at a rim speed of a mile a minute and drives full seventy thousand spindles—is not that an object of interest? Those wonderful creations of man which blow the air for smelting from 80,000 to 95,000 net tons of pig iron in a single furnace in a single year, say from 225 to 275 tons every day,—do they not deserve a word of admiration? And the engines which roll daily in a single mill a thousand tons of rails, are they not worth considering? Does not the engine which balances like a plaything in its grasp, the hammer of one hundred and twenty-five tons and hurls it with all its weight added to the mighty power of steam behind it, upon the white-hot shaft of the coming warship—does not that command a moment, too?



THE GREEK ÆOLOPILE—ORIGIN OF THE STEAM-ENGINE

WATER POWER IN NEW ENGLAND.

By Samuel Webber, M. E., C. E.

THE young engineer, newly graduated from our technical schools and whose reading has been chiefly confined to European—more particularly English text-books, little realizes the extent and value of the water power distributed over the eastern slope of the Appalachian range in the numerous and abundant streams winding their often tortuous way toward the sea. The aggregate of this power has suffered notable diminution as the result of reckless destruction of forests, but what remains is sufficient to excite the wonder of English travellers when first fully comprehended by them.

To the Englishman reared in the land that witnessed the birth of the modern steam-engine and accustomed to see all about him mills and factories driven only by steam, one of our large mills, taking its power through an improved modern water-wheel from a magnificent stream and steadily turning out its products independently of coal or other fuel supply, is, indeed, always an interesting sight.

It is true that the first cotton mills of Arkwright and Strutt were driven by water power obtained from the Derwent and the Dore; but these mills were mere infants when compared with our giant factories distributed along streams to which the small rivers that drove the first "water-frames" are mere pigmies.

Although, as shown in a previous article, the American saw-mill, driven by water power, has played an important part in the destruction of the forests which acted as storage reservoirs, the great water powers of the Eastern States have been mainly applied to the cotton manufacture. I shall return to this part of the subject after a digression to the subject of Power.

The total power of falling water consists in its weight and volume, so applied as to lose the least of its effect by mechanical or atmospheric disturbances; and to attain such results has been the aim of all modern builders of water-wheels.

The weight of water is usually stated at 62½ lbs. per cubic foot, which is erroneous; and here, once for all, let me say that I shall refer for data on many points to the "Lowell Hydraulic Experi-

ments" of Mr. Jas. B. Francis. Mr. Francis gives a table of the weight of river water at different temperatures, in which we find that it weighs 62½ lbs. per cubic foot at an average temperature of 60° F., and this weight, multiplied by the height of the fall, and the number of cubic feet per second, gives the water power of any stream.

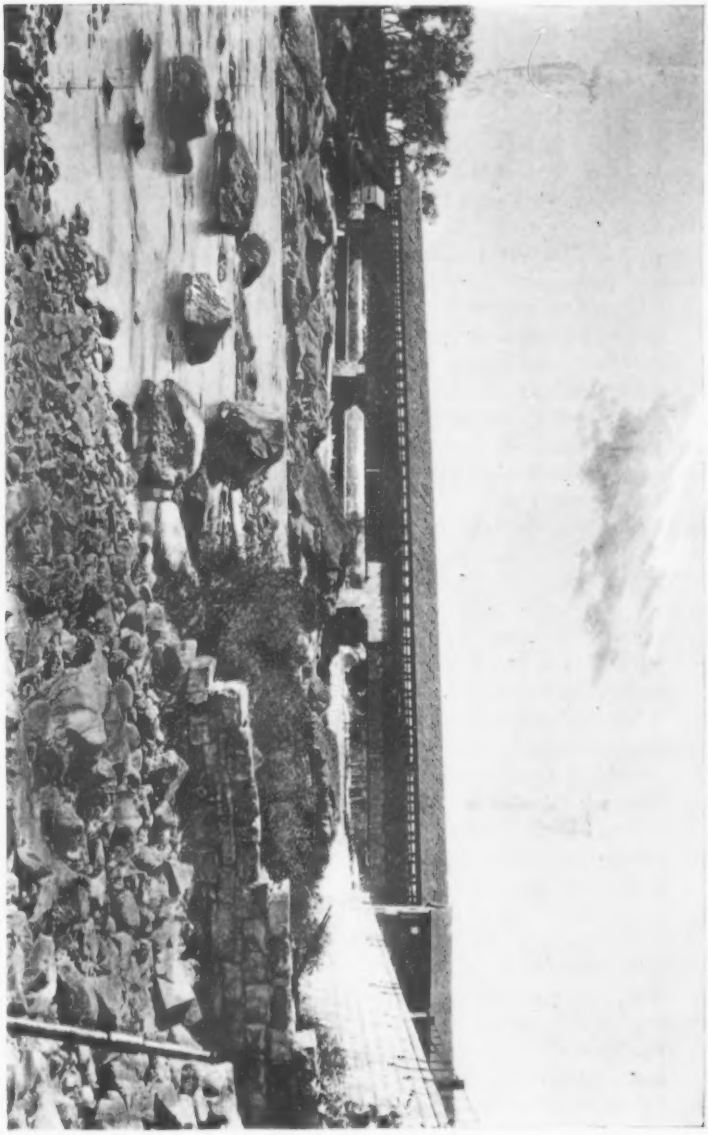
Weir measurement at Holyoke was described in this magazine for June, and for "flume" measure as used at Lowell, the able and important work of Mr. Francis may be consulted.

Another method is that derived from the experience of supplying our great cities with water. This is mentioned as likely to be of value to those who wish to utilize the great water powers of the Southern States. This method is based upon the drainage area and the annual rainfall.

Lorin Blodgett, in his "Climatology of the United States," gives the annual rainfall of the eastern slope of the great Appalachian range as about 42 inches, which is equal to 3 cubic feet per second on each mile of area. Of this, in New England, one-third, approximately, may be depended upon for water power; the rest either soaks into the ground or is carried off by evaporation. New England is, however, particularly favored with great natural reservoirs—lakes and ponds—relics of the great "ice age" with which her surface is thickly studded. Maine is especially fortunate in this respect. A very large part of her area is covered with them. Whether these reservoirs are simply accumulations of water in depressions formed by primeval contraction and warping of the earth's surface, whether scooped out by glaciers from the original "Laurentian" range now almost obliterated, or formed by the deposit of glacial moraines across the beds of streams, I will not undertake to say; but they are these: the Moosehead, Grand Lake, Sebec, and the "Rangely," or "Androscoggin Lakes," in which water is retained by artificial dams and channels at their outlets in the spring and early summer, to be let out in seasons of drought and low water to supply great mills at Bangor, Augusta, Saco and Lewiston.

New Hampshire is almost equally favored. Sunapee, Newfound, Umbagog, Madison (Great East Ponds), Merrymeeting, and last and greatest, Winnepesaukee, with its adjuncts of Asquam, and Winnesquam, all serve to hold the waters for the mills below. Winnepesaukee and its branches have been literally invaluable to the great manufacturing cities of Manchester, Lowell and Lawrence on the Merrimac River.

Massachusetts and Connecticut are also thickly studded with



THE BRIDGE AND DAM AT AMOSKEAG FALLS, MANCHESTER, N. H.
Guard gates and masonry abutment at the head of the canal to the right.

smaller lakes, the water powers of which are utilized ; and it is from observations on these waters that the mean annual flow of about one-third that of the total rainfall has been determined.

When we get to Vermont the case is different. We strike the Green Mountains—the northern extension of the Great Appalachians—and these have not been so ground down by the glaciers, as the country to the east and northeast of them. There are very few lakes, and no prominent water powers. The features of the country are more nearly approximate to those of ranges south of the reach of glacial action;—say in Pennsylvania, Georgia and North Carolina. The latter named States have many large and valuable water powers, many of them yet undeveloped, but it will not be safe to depend on an average flow of even ⅓ of the rainfall, unless artificial reservoirs are provided by dams, to hold back the waters in the night and get a double quantity in the day-time. The summer flow falls in these States to one-sixth the average precipitation.

To return to the historical part of the subject, the saw-mill and the grist-mill were, of course, the first applications of water-power to industry, and the trip-hammers, rollers and forges of the iron-works were the next, but the cotton manufacture has been the great agent in developing the wonderful water powers of the United States.

After some small attempts at the towns of Beverly and Bridgwater, Mass., aided by the State of Massachusetts, Moses Brown, of Providence, R. I., built a small mill at Pawtucket, R. I., in which Samuel Slater, who had just come from England with a knowledge of the cotton spinning frames recently invented by Arkwright, started 72 spindles on the 12th of July, 1793. From this modest beginning the use of the water of the Blackstone River has gradually extended, until, now, a series of mill-dams and ponds, like the connected links of a chain, extends from tide-water below Pawtucket, to Worcester, Mass.

In 1791, the "Society for the Encouragement of Manufactures in New Jersey," was organized at New Brunswick. On July 4, 1792 this society met at Godwin's Hotel in Paterson (named for the then Governor of New Jersey) and made appropriations for utilizing the falls of the Passaic River at that place. The execution of the plans was entrusted to Major L'Enfant, a French engineer, who had laid out the city of Washington. Unfortunately his plans for the water power were on the same gigantic scale as those for the

CENTRE OF AMOSKEAG DAM, MANCHESTER, N. H.—MILLS NOT RUNNING.

city, and reached from tide-water to far above the falls at Paterson. The seheme was too large to be handled, and in 1793 the business was placed in the hands of Peter Colt, then "Comptroller" of the State of Connecticut, who built canals, raceways and a small mill in which was begun the spinning of cotton yarn in 1794. The enterprise did not prove successful; and, in 1814, his son, Roswell L. Colt, bought up a majority of the shares and founded Paterson on a firm basis, though diverting it from the plan of cotton spinning.

From the year 1793 up to the War of 1812, a large number of small cotton mills (Dr. Bishop says 87) were built on the small water powers in New England and the Middle States. These were, however, only "spinning mills," and the yarn which they produced was woven into cloth by the farmers' wives and daughters in their neighborhood, who used the old "hand-loom" of the period.

The War of 1812 laid the foundation of the cotton manufacture on a large scale; and in 1813, Messrs. Francis C. Lowell, and Patrick T. Jackson, of Boston, bought out "Bemis' Paper Mill," in Waltham, Mass., on the Charles River, and erected a mill of 1700 spindles, with cards and looms, being the first mill to unite all the processes of producing cloth from cotton, under one roof.

This led to a second mill of 3584 spindles, with all the other machinery, and the success of this mill led to the foundation of Lowell. There also was the origin of the term "mill-power," commonly used in the Eastern States.

It was found that to operate this ("Waltham") mill, 25 cubic feet of water per second on a fall of 30 feet were required; and on this basis the water power obtained at Lowell was apportioned in 1823. The same measurement was afterward used not only on the Merrimac River at Manchester and Lawrence, but at Laco, Dover, Lewiston, Holyoke and all over New England. If the fall was less than 30 feet an equivalently greater quantity of water was allowed.

The first mill at Lowell,—the "Merrimac," used the whole fall of 33 feet; but on account of the enormous size of the breast wheels then in vogue, the remaining water was used on two levels, of 19 and 14 feet respectively, the lesser fall being used on the lower level where the mill sites were wider.

From Lowell, in 1838, sprang Manchester, 32 miles farther up the river, where a small spinning mill had been built in 1810; and in 1846, Lawrence, 13 miles farther down was commenced. At the present time, the water of the Merrimac is almost as fully utilized as that of the Blackstone, although the cost of inland transportation has left some of its upper falls yet unemployed.

It is a curious fact that the power—10,000 H. P.—obtained respectively from these three great falls on the Merrimac, is nearly equal; Manchester with 49 feet fall having the water from a drainage area of 2790 square miles, Lowell with 33 feet fall, from 4000 square miles, and Lawrence, with 28 feet fall, from 4600 square miles.

All of them have long exceeded their supply of water, and use steam to a great extent to supplement, not to *supersede* water power, as is often erroneously stated.

The water-wheels of Lowell (including the Concord River) all except three being turbines, now aggregate 23,000 H. P., and the steam engines 28,000 H. P.; the wheels always being used to the full extent of available water.

From 1823 to 1830, all the most accessible water powers in New England were taken up; the Nashua, Cocheco, Contoocook and Salmon Falls rivers in New Hampshire, the Saco, in Maine, the Chicopee, in Massachusetts, the Quinebaug, in Connecticut. In 1826, the Great Falls of the Mohawk, at Cohoes, were made to do duty, dividing their total fall of 105 feet into five different levels.

Since that date, Manchester and Lawrence on the Merrimac, Lewiston, on the Androscoggin, Holyoke and Bellows Falls on the Connecticut, (the two latter, however, mainly for paper mills) and

THE DAM AT LAWRENCE, MASS., IN A SPRING FRESHET.

many other smaller towns in New England have grown up on her waterfalls, the great bulk of the power being used in the manufacture of cotton and wool; although the working of metals, and the construction of machinery and tools constitute no unimportant share of New England industry. Cotton and paper are, however, the great consumers of power; and as the manufacture of paper requires a great quantity of water for other purposes besides power, the pure waters of the Connecticut have been largely devoted to that purpose, and Holyoke has become the great paper city. The cotton manufacture has since spread southward, utilizing the Falls of the Rappahannock at Fredericksburg, and the James at Richmond. A great cotton industry has been established on the Savannah at Augusta, Ga., and on tributaries of this river at Graniteville and Langley. The Falls of the Chattahoochee at Columbus, have also been partially employed; and all the smaller water-falls of the Southern States in close proximity to the cotton fields are being brought into service for the manufacture of heavy cotton fabrics, in which the saving of freight on the waste raw material forms an important item.

I have purposely left the progress of Fall River unnoticed so far, as it bears on the last and principal point—the cost of power.

The little Quequechan River, flowing from Watuppa Lake, with a fall of over 100 feet in a few hundred yards, gave the name to the town, and on it, the Troy Manufacturing Co. built their first mill in 1803, the town being then called "Troy." In course of time other mills were erected—the Pocapet, the Anawan, the Fall River Manufacturing Company's mill and the Metacomet, crowded close together down the slope of the hill, each mill delivering the water from its wheels into the pond of the next one, until the water finally reached Mount Hope Bay, at the American Print Works, and Fall River Iron Works. Although now the great seat of the steam cotton mills of New England, Fall River owes its name and its origin entirely to its long exhausted water-power. When that was all taken up, the advantageous site on tide-water, permitting great saving in the freight of both cotton and coal from New York, and the shipment of goods to both New York and Philadelphia, led to the erection of steam mills. Thus Fall River is often quoted as an instance of the superiority of steam to water power. Those who do so, do not take into account the differences in the fabrics made and the methods of business respectively in Fall River and Lowell. While a pound of cotton is the basis for six yards of goods at Fall River it does not produce much over three yards at Lowell, Nashua and Manchester; and while in the latter town it requires about 30 H. P. to drive 1000 spindles, it only takes 15 H. P. at Fall River.

While the diversity of fabrics made in the above towns has compelled the employment of experienced cotton buyers at the South to select the proper grades of cotton—a treasurer in Boston to manage the finances, and selling agents in Boston, New York and Philadelphia to watch the markets, decide on the styles, and distribute the goods, Fall River started on cheap print cloths made up of a low grade cotton mostly bought in the New York markets, and her goods were sold to a few great print works on whom the cost of distribution fell. Thus one man, at a moderate salary, was cotton buyer, treasurer and selling agent in one. These economies together with reduced freights, effected a saving which offset the extra cost of steam.

As this question of the cost of power has of late been the cause of a great deal of discussion, I will quote a few words spoken at the meeting of the American Society of Mechanical Engineers, at Scranton, in October, 1888, by Mr. Thos. J. Borden, of Fall River, an experienced manufacturer, employing both water and steam

FRONT VIEW OF THE ARMORY MILL, MANCHESTER, N. H.

power, and a graduate of the Lawrence Scientific School: "My experience in manufacturing convinces me that power can be derived from water under favorable conditions with greater economy than from steam under the best of circumstances—except in the immediate vicinity of coal mines—provided the quantity of steam required in the processes of manufacturing is not large in proportion to that needed for power."

For full data on this point I would simply refer the reader to the discussion on Mr. Main's paper on "The Use of Compound Engines" in Vol. 10 of the Transactions of the Society of Mechanical Engineers, and to the discussion in Vol. 11 of the paper by the same gentleman on the "Relative Cost of Steam and Water Power."

Fall River has overdone the print cloth business and gone over to more diversified fabrics, which will probably increase the cost of operations to a point beyond any figures seen by Mr. Borden.

One word more on this topic: The estimates offered by the gentlemen above referred to are based on plants of 1000 H. P. which are abnormal, but from which we may deduce an average cost of $25 per annum per H. P. for steam, with compound engines and high pressure boilers. Now, the cost per H. P. of "plant" for steam power diminishes with increase of size, while with water power it usually increases; and as a plant of 300 H. P. would be nearer an average, the comparison is hardly fair. The late Mr.

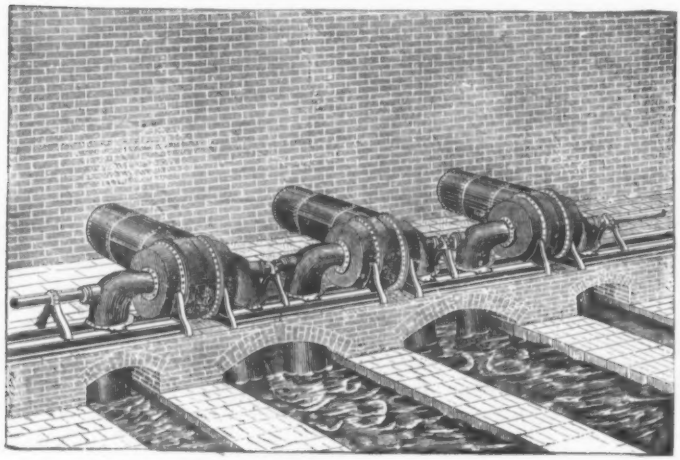
Samuel Batchelder (one of the oldest and earliest cotton manufacturers in the country, and the first agent of the Appleton mills at Lowell) in a little book which he published in 1863, on the "Introduction of the Cotton Manufacture," gave the cost of water power, *including land*, at $15 per H. P. per annum; and the writer is fully satisfied that it can be and is produced in suitable locations at a total cost for dams, wheels and attendance at a cost of from $10 to $13 per H. P., not including land.

However, I must refer those of the readers who desire more detailed information on these points to the papers above cited and subsequent discussions of them in the Transactions of the American Society of Mechanical Engineers.

There are yet many great unused water powers in the Southern States, nearer the cotton fields, than the latter are to the coal beds, and these, with a proper amount of judicious foresight, are yet to be of very great value, if they are not overestimated and overloaded

The modern improvements in turbines, make the first cost of the "plant" very much less than in the old days of huge breast-wheels, thirty feet in diameter, with massive wheel-pits of masonry such as were in use in Lowell in 1841, in the days when the writer began his mechanical apprenticeship.

It little matters now, how high the fall is. The turbine



THE LATEST DEVELOPMENT OF THE TURBINE.

runs well under any head, and the higher the head the smaller is the wheel needed. If on horizontal shafts, set 24 to 26 feet above tail-water, so as to keep the belts dry, the higher the head the better, and the less is the consequent cost ; and on the mountainous streams of the Southern States, these advantages will be of great value.

The earlier statesmen of our republic,—Washington, Madison, Jefferson, Gallatin, all advocated the establishment and encouragement of American manufactures, and at that period the abundant water-power of the Eastern States was the only means by which this end could be accomplished.

The steam-engine was in its infancy. The great coal-fields were undiscovered. The only fuel was wood, and that could not be used to make steam with economy in competition with the coal-beds of England, even had the steam-engine been as perfect as it to-day.

Nature came to our aid. The energy and enterprise of New England, applied to the building of dams across her mountain torrents, and to the *naturalization* and improvement of the best water-wheels to be found in Europe, called the great law of gravitation into play, and thus American manufactures were established.

Had it not been for these water-falls we might yet *practically* have been colonies of Great Britain, dependent on her for clothing and tools, for necessities as well as luxuries ; while our part in the world's industry would simply have been to raise grain, cattle and cotton, and to supply food to European laborers converting the cotton into cloth for which this nation would have been the principal market.

NEEDED REFORM IN OUR PUBLIC WORKS.

By Lewis M. Haupt, A. M., C. E., etc.

THE Constitution of the United States was framed by delegates from all the thirteen original States except Rhode Island, who met in Philadelphia soon after the close of the Revolution, and after protracted deliberations and great difference of opinions adopted it on the 17th of September, 1787.

It was ratified the next year, and the first session was held under it at New York on March 4, 1789.

In commenting on this great achievement, Chief Justice Joseph Story said in 1840: "Many of those pure and disinterested patriots who stood forth the firm advocates of its principles, felt that they had a higher duty to perform than to flatter the prejudices of the people or to subserve selfish or sectional or local interests. * * * They scorned every attempt to rise to power and influence by the common arts of demagogues; and they were content to trust their characters and their conduct to the deliberate judgment of posterity."

Article I, section 8, relative to the powers of Congress, provides and authorizes it to lay and collect taxes, *to provide for the* common defense and *general welfare; to regulate commerce* * * * among the several States; * * * *to establish* post-offices and *post roads* and to perform other functions.

At that date transportation was in its infancy, steam as a motor on water was in embryo, and railroads were scarcely conceived even in imagination. Hence the momentous import of the provision under which Congress now legislates upon that class of our public works which has played so important a part in promoting the general welfare, was not realized nor anticipated even by the most sanguine of the founders of this Republic.

Barely a century has lapsed, and we are interwoven with bonds of steel covering over 160,000 miles; with waterways which enclose and permeate the entire federal domain; and with highways which unite these two systems and serve them as feeders, having a development in miles innumerable.

The railroad system has been built up little by little by concentration of capital, through corporations that have gradually combined for better service, mutual protection and more economic

results, until to-day the tonnage reaches figures which are incomprehensible (70,000,000,000), and the saving to the country in the reduced cost of moving its traffic has added untold millions to the public weal.

With few exceptions, however, the development of the other two systems of highways and waterways has not kept pace with that of the railways—nor is this very surprising when it is considered that the methods of administration to which the former are subjected differ so radically from those of the latter.

In the case of common roads, the construction is frequently left in the hands of parties elected not because of any special qualifications or technical knowledge, but for their genial or liberal disposition or their ability to control the suffrages of their followers; the administration is in like manner controlled by boards of supervisors who are chosen because of their integrity and general ability in every profession, trade or occupation other than engineering. In many States the road laws are in a chaotic condition, and there is no attempt made by their governments to control the roads, codify the laws or to otherwise improve their condition.

The methods of administering the public works on that system which is capable of producing the greatest benefits to the country in all departments of trade and manufacture, is not as in the case of roads one of dissipation amongst myriads of individuals, but on the contrary, it is one of concentration in the hands of a limited number of men of recognized integrity who have been specially prepared for *military* service by their country, and who are placed in charge of the numerous localities where works are in progress, at the option of their chief. It is a kaleidoscopic monarchy wherein the supervision of important works may be and is frequently changed to suit a caprice.

But this system is moreover dependent for the means to carry on the works continuously, on the vicissitudes of Congressional appropriations, which are great and which have added largely to the expense of works in progress, or have prevented the inception of works of great importance, or have dissipated the public revenue upon works of no value, or which could not be utilized because they did not form a connection with some accessible waterway.

The meagre results attributable to this policy are sufficient not only to justify, but to require an investigation as to the underlying causes for the condition of affairs with a view to suggesting a remedy—and yet there can be no question as to the great impor-

tance and value of the appropriations made for the works upon our rivers and harbors. There is probably no like amount of money expended which is so far reaching in its benefits to the whole country. It seems to be forgotten that commerce is reciprocal, and that what tends to develop one section will react upon all others having intercourse with it. Hence the policy which has so long characterized our legislative methods has been too restricted and local—and has arisen from the desire to secure for each and every district at least a pro rata of the public appropriations, without regard to the legitimate or imperative need of other sections, resulting in much mischief. History is replete with illustrations, a few of which only will be cited in support of the general argument.

In early days the powers of Congress were so jealously guarded by the States and the public treasury was so impecunious, that for some years no general appropriations were made and Congress was content to pass special acts authorizing the States, corporations or individuals to levy taxes or duties on commerce whereby they might construct certain much needed improvements. Thus the first act relating to public works of this class was one passed August 11, 1790, ratifying certain acts passed by the States of Maryland, Georgia, Rhode Island and Providence Plantation, authorizing the formation of a "River Machine Company" at Providence; appointing Wardens for the Port of Baltimore, Md.; and approving a duty on tonnage for clearing the Savannah River in Georgia of wrecks and other obstructions.

Such was the policy of the Government when in the spring of 1812 the Commissioners appointed by the State of New York to memorialize Congress for aid to construct the Erie Canal presented their appeal. Their Report,* which is rare and valuable, contains many sage reflections, from which a few extracts will be appreciated.

The Commissioners addressed the Legislatures of the several States inviting their co-operation; they also sent a delegation with letters and the necessary papers to President Madison and to Congress.

The report narrates that the deputation was forced to mix up

* Report of the Commissioners appointed by an Act of the Legislature of the State of New York, entitled "An act to provide for the Improvement of the Internal Navigation of the State," passed April 8, 1811. Signed by Gouv. Morris; S. V. Rensselaer; De Witt Clinton; Simeon De Witt; W. North; Thomas Eddy; Robt. R. Livingston, Albany, March, 1812.

the canal scheme with others (some of which related to merely local interests) and to refrain from asking any advance or appropriation of money. It did, however, venture to solicit a grant of land not to take effect till after the canal should be completed at the expense of New York. After considerable delay and after learning that unless grants of land were also made to other States for various purposes, they had no hope of getting a grant for New York, the Commissioners accepted the situation and at the request of the Congressional Committee prepared a bill with a preamble setting forth the expediency of opening inland navigation as soon as circumstances would permit, specifying various communications which might be effected by canals in connection with rivers and other inland waters, and enacting that the then unappropriated lands in Michigan territory, and the land in Indiana territory lying north of the fortieth degree of latitude, be appropriated for the opening of such communications. The restriction that none of these landsshould be sold was imposed, and the lands were to be redeemed twenty years after the loans were effected.

The bill in its preamble clearly set forth the importance of the general system of waterways projected at that early date.

The system comprised a communication along the sea-coast, from Boston or Barnstable Bay, to Narragansett or Buzzards Bay, from Raritan River to Chesapeake Bay, and from Chesapeake Bay to Albermarle sound; also a communication from Lake Champlain to Hudson River, from Lake Erie to Hudson River, the Susquehannah, the Muskingum and the Wabash, from Lake Michigan to the Illinois, from the Susquehannah to the Schuylkill and the Delaware, from the Roanoke above its great falls to the Chowan or Mehurin, from the Tennessee to the Tombigbee, from the Cooper River and the Black River to the Santee, and from the Savannah to the Tennessee; also to construct locks around the falls of the Ohio, and to meliorate the navigation of the Potomac, above the falls.

The lands thus set apart were apportioned as follows: To Massachusetts, 1,000,000 acres. New Jersey was to have 500,000 so soon as a canal, navigable for vessels drawing six feet of water, should be opened between the Raritan and Delaware rivers, and on condition that no tax, toll or impost should be levied for the passage of vessels more than what should be found needful to pay the annual expense of superintending and keeping the canal in repair. To Delaware was apportioned 400,000; to Virginia

200,000; to New York, 400,000 for the Lake Champlain canal, and 4,000,000 for the Erie Canal, under the condition that the latter should not be less than 63 ft. wide at top, 45 ft. wide at bottom, and 5 ft. deep. Pennsylvania was to have 100,000 for the Lake Erie and Susquehannah Canal; Ohio, 100,000 for the Lake Erie and Muskingum, and 100,000 for that to the Wabash; to New York were apportioned 100,000 for the Lake Michigan and Illinois River Canal; to Pennsylvania 800,000 for the canals from the Susquehannah to the Schuylkill and thence to the Delaware; to North Carolina, 300,000; to Tennessee, 200,000; to South Carolina, 200,000; to Georgia, 1,000,000; to Kentucky, 300,000; to Maryland and Virginia for the Potomac, 200,000.

The total acreage thus proposed to be granted was 9,900,000, of which 4,500,000 was to aid New York. Yet notwithstanding this liberal apportionment it appears that the objections to assisting one of the integral parts of this Union was so great that the bill was smothered by a sub-committee, and New York was compelled to carry on the work from her own resources, thus transferring to her the commercial supremacy of the western world, and leaving her sister States without the Federal assistance and internal development they might readily have secured, but for the narrow sectional policy which was permitted to prevail.

Had these various projects been executed, the supremacy of the United States as a maritime nation would have been assured and the prosperity of her people have been greatly augmented. As it is they have been allowed to slumber, with but few exceptions where private capital has been employed to execute some of the interior lines; and these in many cases have exercised so controlling an influence in the rates of freight that the railroads have waged against them a war of extermination, resulting in their purchase either by the railroads with consequent decadence, or by the Government where the line formed an important part of a national system which it was found expedient to maintain.

The Erie Canal which was begun in 1817 and opened in 1825, is 351 miles long and cost $5,700,000—or about $16,240 per mile. In 1852–53 the revenue was over $3,000,000. Its capacity is about 5,000,000 tons, and it has paid for itself many times over.

The interior Atlantic coast line, the most important link in this great system, is still awaiting the energetic and intelligent action of a future revival of interest in our public waterways.

Another instance of the operation of sectionalism in determin-

ing the course of public legislation, is to be found in the events connected with the appropriations for and construction of the iron pier near Lewes, Delaware, upon which $368,453.66 have been expended; yet the pier has never been used and its superstructure is so decayed as to be unsafe. The history as told by Hon. Willard Saulsbury, ex-Senator, in a letter to J. S. Gibbons, President of the Junction and Breakwater Company is published in the Report of the Chief of Engineers for 1871

The facts relative to the appropriation for this pier are that in 1869-70 a bill was before the Senate which contemplated devoting hundreds of thousands of acres of public lands to aid in the construction of one or more railroads in the West. Mr. Saulsbury thereupon claimed that the voting away of public lands exclusively for the benefit of the Western and Pacific States was unjust to the Atlantic States, which also had a reasonable share of interest in these lands; and he offered an amendment to the bill appropriating 200,000 acres to the Junction and Breakwater Railroad to build a pier at or near Lewes. The amendment was defeated; but senators from the Western and Pacific States having intimated to Mr. Saulsbury that they would not object to voting a money appropriation, he introduced a bill authorizing such an appropriation, which passed both houses without serious opposition and soon became a law. The letter cited emphasizes the fact that the pier was not located where it was intended to be placed; which may account for its never having been used by the railroad company. It has since been severely injured by storms. To make it available it is estimated that $93,000 more will be required. Thus to secure the vote of an Eastern State, has cost the Government over $368,000 to no purpose.

A still more recent instance is to be found in the methods pursued in securing the appropriation of $6,200,000 for the completion of the futile experiments being carried on at Galveston. The *Daily Light* of that city, in a recent editorial, says:

"All Texas does not know the tactics employed by Galveston to influence deep water legislation at Washington. Rumors of Galveston's peculiar methods have been prevalent; not loud, but deep, and the correctness of these rumors has been quietly investigated. So far as can be ascertained the citizens of Galveston have already expended $200,000 at Washington, and their lobby at the National Capital has made a call for $50,000 more. * * * If the $200,000 was required to carry the bill through the Senate, * * how much will be required to insure its passage through the house? * * * The *Light* does not charge that any improper use has been made of the Galveston lobby fund, it only cites attention to

the expensiveness of the affair; an expensiveness that in Galveston's case seems ever, by some strange fatality, to attach to the United States' Engineer's recommendations and operations in her waters. Here is a round quarter of a million gone, and not one grain of sand moved from that bar on which so many hundreds of thousands of dollars have been sunk to no end."

These are but a few of the many typical instances which might be cited of the operation of the vicious principle pervading the appropriations made to different districts to secure patronage. The contest over the "spoils" degrades the public treasury to the level of plunder, and those engaged in its wholesale distribution for partisan purposes to the grade of demagogues. It makes it well-nigh impossible to secure an appropriation for urgent and meritorious works, without putting localities to heavy local taxes both in time and money to secure the prosecution of works for the public as well as for the local interest. Under the present *régime*, a lobby or delegation of prominent citizens or of representative bodies, must abandon their business, travel long distances, maintain advisors or experienced lobbyists to watch their opportunities and to further their projects on every occasion, and even then the results are often doubtful. Moreover, the time consumed by committees in listening to controverted opinions is so great that frequently the entire bill fails for want of time to complete it, and the country suffers an incalculable damage due to the cessation of improvements for the year while the officers and plant must be maintained.

These defects can only be remedied by a radical change in the mode of administering the works and making the appropriations, which shall supplant sectionalism by patriotism; permanency of residence for itinerancy in the officers in charge; individual responsibility for *esprit de corps;* a life tenure coupled with competency for a capricious interchange of station and duties; and promotion upon the basis of competitive examinations for that of seniority as in a military succession.

Bills have of late been introduced into Congress embodying most of these features and have been reported favorably. It is only necessary that the public—those who are most interested and who will be most greatly benefitted, should be aroused to the desirability of such a reformation, that they may instruct their representatives accordingly. Thus the country may be able to secure the completion of these great public works which have been held in suspense for so long a time by local prejudices, ignorance and self-interest.

ENGINE-ROOM CHAT.

By Col Loquial.

SIMPSON'S engineer amuses me—at times—but he must be awfully wearing to Simpson. He is as excitable as a hen with one chicken. If you suggest that anything is going wrong he is up in arms at once. He goes off at half-cock on the lightest provocation, or lack of provocation; expresses virtuous indignation at his competency or his honesty being doubted, and is forever metaphorically dropping his overhauls down over his boots, prepared to step down and out of his place. He's "had charge of larger plants that cost more money, and never had any interference or suspicion"; he's "wearing his soul-case out now to keep the darned old establishment going," and if he's "going to be stopped every two days to take some one's advice, or try some thing new," darned if he "won't quit right now while safe and alive."

The trouble with Mallet is that he gets hot in the collar too quickly. If he were less excitable he would learn more from his own experience and that of others. The cool head wins.

* * *

Did you ever have a "lightning engineer" about your plant? I don't mean one who could run the dynamo, but one whose every movement suggested that it was the result of an electric charge suddenly applied to the muscles proper to produce that movement. Elkins has one. He is forever darting into the engine room; rushing to the oil-can; dabbing at an oil-hole; grabbing a bunch of waste; mopping down some greasy place; bowling the waste into a corner; seizing a wrench; yanking a bolt-head to right or to left; twisting open a pet-cock; patting the end of a journal to see if it is hot; gyrating around the connecting-rod in search of "pounds" present or to come, and so on, *ad infinitum*, alternating all these lightning-like attentions with dives into the boiler-room; glances at the pressure-gauge; glimpses at the water-column; peeps into the fire-box; and short but intense looks into the ash-pit. Forever on the jump, never for an instant either still or thoughtful, that man wears himself out without keeping things in better condition than his slower but more systematic neighbor. When he's fifty, he'll be a hundred.

* * *

Almost every man has a pet hobby and a favorite specific for all the ills that flesh is heir to. Mattson's engineer has a remedy that is good for men, women and children, horses and dogs, engines and boilers. No matter what ails any of these, Brother Warden recommends "Karrysene." For chilblains, sore throat, fleas on dogs, quarter cracks in horses' hoofs, washing clothes, cleaning paint, cutting rust, removing scale from boilers, thinning machinery oil "Karrysene" is the thing; the very thing; the entire thing, and the only thing; and for almost anything else that comes up, or which is likely to come up during the next quarter of a century, I suppose that he will confidently recommend it, whether it be ingrowing nails or a tendency on the part of the superheater gaskets to dissolve into thin air and disappear. When he dies, I expect he will request to be embalmed with "Karrysene" and buried in a "Karrysene" stained coffin—unless he knows of a crematory where "Karrysene" is the only fuel employed.

* * *

Do you know that those Italians over by the river are taking your "ashes," or what you and your fireman in your combined wisdom call ashes, and are burning them in their little stoves? Well it's time you did.

Of course I don't mean that they are burning the whole mass; but they are doing better with your ash-heap than with any other in the city. Now while I don't believe in gleaning too closely in the har-

vest field, I think that you can't be much too exacting about getting full duty out of a coal bin. There's loss enough from slate and dirt, and exposure to the elements, without your deliberately throwing away 15 to 20 per cent. of it unburned or half-burned. Its the stoker's fault for being so wasteful, but its just as much yours for letting the good coal be carted right past your window and picked up almost under your nose. If you give that fireman to understand that he'll have to riddle those ashes and use the good coal out of them, he won't be so wasteful any longer.

* * *

Here you are growling away because you can't make enough money to retire from business about the second year; straining every nerve to do as big a trade as your opposite neighbor. You're going about it the wrong way. Your selling department is all right enough. That isn't the trouble here. Your buying department is the weak corner. In your business, as in every other, $a-b=x$; a, is the receipts, b, the expenditure, x, the profits. If you can't make a as big as all the rest of the alphabet put together, trim down b. One part of b is your engine-room and boiler house; and there I am sure you, yourself, as buyer, are not getting good value for the expenditure. You are turning out 400 barrels of flour a day; and to get that are using 8½ net tons of coal each 24 hours. It should not take over 30 lbs. per barrel, or six net tons. Smithson is doing it on that. Suppose you reform.

* * *

What do you call this place, a shoe factory, or a smoke factory? It says shoe factory on the gable-end and smoke factory at the stack. You are paying $4.75 for good coal and are distributing about 20 per cent. of it over the face of the earth as soot and smoke. The worst of it is that you're not even a benefactor, either intentional or unintentional. Nobody but the coal dealers and miners benefit by your extravagant misuse of good fuel. That stack costs more to keep, as things are now, than a span of horses. Tell your stoker that he needs rest; or if he must have muscular exercise, to shovel the coal from one side of the yard to the other and back again. He fires too heavily and don't know how to manage what poor draft he has. Put 20 feet more on that chimney, and moderate that stoker's transports a bit, and you will save about $15 a week in coal.

* * *

"Circulation?" My dear sir, that boiler hasn't much of anything else. You need not worry about that. There's a regular geyser over the crown-sheet, and you'll find mill-races all through it. If you were as sure of your cylinder heads as you may be of your circulation you might rest easy.

The principal trouble with that circulation is that it is misplaced. There is water circulation through the steam space, and steam circulation through the water space. The result is that the boiler is foaming at the mouth all the time, and you have to keep the drip-cocks open all the time, You need be in no fear of mud baking on anywhere; it is kept scoured out too strongly and constantly by the whirlpools and water-spouts which course through it from one end to the other. If you were to burn shavings or some such fiercely-burning fuel, that boiler would turn itself inside out.

* * *

I'm not much of a betting man, but I'd wager a ten dollar bill against a turnip that your fireman has never been inside that boiler in a twelvemonth. How do I know? Because he has a 54-inch waist, and there isn't room enough in that generator to admit his generous proportions. In fact, I know of only one fireman who has ever made the through trip; and he did it because he was a little fellow and able to squeeze through narrow places. It's all a mistake getting compactness at the expense of accessibility. Some day that boiler won't be so compact as it is. It will be distributed with more or less impartiality all over the country. A boiler must have room for every part to be accessible by a man's hand and arm, and its main portions should admit his whole body. Otherwise it will not be inspected or at least not as an entirety.

Did it ever strike you what trouble you'll be put to when the time comes for you to draw one of those tubes and replace it with a new one? Of course getting the old one out will be comparatively easy, because it can be cut in half in the middle; but that's not feasible with the new ones; and judging from the present arrangement of your boiler room you'll have to take down a wall and move a section of that bluff in order to get the tube in. "Never thought of that?" Well, I'll be bound that the patentee never suggested it to you. It's my impression that you'll think of it when one of those tubes gives out, even if your mind don't revert to it semi-occasionally before then.

There's no use in buying or putting in anything—engine, boiler, wheelbarrow, or what-not—without taking thought and making provision for the repair and renewal of some part or other.

* * *

So you've put in one of those new-fangled boilers, with nine hundred and seventy-five pieces, and only about ten of them alike? Did you ever think to take a day off and count the joints? Did you ever think how many times greater the chances of leaking were, than with the old-fashioned horizontal tubular boiler, or even than your own old sectional? You have all the disadvantages of both the plain cylinder and the sectional. You put it in because your brother-in-law owns stock in the company that makes it. You never took the trouble to find out how that one was working over in the cracker-bakery did you? Well, if you had, you would have found out that after the first three months that one did nothing but sizzle and dribble and leak. It's half full of horse manure and bran, now, put there in the vain hope of stopping its weeping.

Next boiler you put in you'll buy it with a view to record rather than who makes it.

* * *

That boiler is its own worst enemy. It is working its own ruin every working day. It is supported on cast-iron brackets riveted firmly to its shell, and these are imbedded in the masonry of the setting, so that every time the fire is started up and the boiler lengthens, either the walls are forced slightly apart lengthwise, or the boiler is bent in the middle, or both. Every time that the boiler cools down the reverse takes place. It is only a question of time when this constant heating and cooling, expansion and contraction shall have wrought injury to boiler or setting, or both. What should have been done, was to put all the brackets, but one pair, on rollers—just a crop end of shafting makes as good a roller as any one need ask for—so that as the boiler length changed it could move to and fro; the rollers playing on plain iron plates set in the brick-work. Make a mental note of this, to be used next time you put in a boiler.

* * *

"Can run that engine with his eyes shut, can he?" Well, so could you or I after a week's practice with them open. But what I would suggest is that he run it with his eyes full wide open. He isn't doing that now. She's taking steam about four inches earlier on the out end than on the crank end; and she has so much cushion at the out end that she rises in the boxes every time she turns over. There are seven holes in that man's head, and he uses only one of them—his mouth. All six of the others should tell him that she's running hot—but no, he spends his time in telling you and any one else who will listen to him, how much he knows about engines in general, and that one in particular. There is no earthly use for a blind and deaf engineer who can't even smell burned oil. Tell him to let up on the unnecessary accomplishment and to use all the senses the Lord has given him.

* * *

Well, you thought you'd save a little on your engine by lightening up the fly-wheel, didn't you? The result is that every time you are grinding much white lead, you get slowed up when it just happens that a lot of mills get thrown on at once; and if they happen to be thrown out at the same time the engine has to be throttled down until she catches her breath right. Pig iron is cheap; castings are cheap; but experience may be very expensive; and you always have to buy it just when you can't afford it.

The engines in Jewell's Mills, Brooklyn, are painted with coach black, and striped with real gold leaf. Seems reckless extravagance, don't it? Well, it isn't. The engineer feels that he has charge of two noble machines, and gets their best out of them. He keeps a log, and knows what there is in the engines, and knows that "the Colonel" knows it, too. He is not fool enough to lose that job by getting "plug" duty out of high grade machinery.

* * *

MacPhairson is a man of more than iron will; he is more than a man of iron will; he is a man of iron and steel, phosphor-bronze-mounted *won't*. MacPhairson has his own ideas about things. Being a MacPhairson, whose family had a boat of its own at the time of the flood, he does not even assimilate ideas from other and inferior beings; hence any suggestions made to him as to the propriety of "squaring" his engine or the crank end won't be doing five-eighths the work, or giving a trifle more cushion to take that pound out of the man's bearing, are worse than wasted. MacPhairson reminds me of Sancho Panza, who thus expresses his idea of a future state of perfect happiness:

"I would do what I pleased, and doing what I pleased, I should have my will, and having my will, I should be contented, and when one is contented, there is no more to be desired, and when there is no more to be desired, there is an end of it."

* * *

Well, I hardly like to say about that bearing. If you tighten it up, there is danger of its heating and perhaps seizing. If you loosen it more than it is, there will certainly be such a knocking as will alarm the girls, to say nothing of the effect on the crank pin, which is none too large now for the sudden shock it gets on the centres, with that high pressure, short cut-off, and miserable little bit of a fly-wheel. A-Kempis said in reference to affairs religious, "of two evils, the less is always to be chosen," and the same is true in matters mechanical. If you can draw file the pin and scrape the bearings, the liberal use of a good high-grade oil will probably enable you to get along with the brasses closed; but "eternal vigilance" will be required anyhow, whether you slacken or tighten. The pin and brasses should not have been allowed to get that way; but as that is the fault of the man who had the job before, all that you can do is to make the best of the situation. But don't be stingy about price or quantity of oil used.

* * *

Yes, I see him now, that ponderous engineer, with his great breadth of beam and narrowness of forehead; I see him waddling from working-side to back of the engine, and rolling from feed pump to boiler room door, his low shoes clop-clop-clopping on the greasy floor, and his fat hands dangling beside him as he ponderously works his way around the boiler room, his little piggy eyes taking in aimlessly the gauges and the water-glass tube. It takes him about ten minutes to make the full turn of inspection. Then with a sigh of relief he reaches behind him cautiously, ascertains that his big chair is there, lets himself down slowly as becomes a man of his bulk and dignity, mops his sweating forehead and neck, and sets about recovering from the excessive exertion of the past voyage of inspection.

"Says I to myself, says I," "What in the dickens would that man do if word came down that some poor girl's hair was caught in the shafting, and for God's sake to shut down quickly and give her a chance for life?"

I shall never employ a ponderous engineer.

* * *

Whenever I see MacShovel tending boiler, my heart grows sad for the man who pays the coal bills; but then I think of the thousands of unemployed miners in this and other countries, and I see that after all there is a use for MacShovel and such as he; for by direct liberality in the use of coal, and by force of example, he is doing much to increase the consumption and output of the "black diamond." Tusser said long ago:

"Except wind stand as never it stood
It is an ill wind turns none to good."

Still on further reflection, perhaps MacShovel is not an unalloyed blessing even

for the miners. What he wastes in coal, thereby adding to the work and wages that they get, he adds to the cost of the flour in the mill which Mac serves in the capacity of shovel engineer, and if flour costs the miller more it is safe to assume that it will cost more to the consumer also.

* * *

In some respects the average monkey is superior to the average man. He will reach for a thing with the nearest hand. Now a man will turn himself three-quarters around to get his best hand—generally the right—upon what he wants to lift or adjust. What a pity! How much better to be able to handle a wrench, or an oil-can, or any other tool of one's trade, equally well with either hand. It is not so much that we can do more work, if "both-handed," than if only right-handed or even left-handed; but the fact of paying attention to one's self and his power and members, is of itself an advantage, indirect to be sure, but great none the less. There is no use in a man longing for more and better members, when he don't make use of what he has. A "both-handed" man is not only worth more as a mechanic by reason of his ambidexterity, but apt to be of more use in emergencies, because of his habit of adaptability.

* * *

I went past Rice's yesterday, and I saw that man of his sitting on a broken chair, smoking a corn cob pipe, and every time he took a whiff of smoke the main stuffing-box of his engine would respond with a sniff of steam. Smoking is all right enough off duty, for those who are not like myself, too lazy to indulge in it; but when on duty, and when work that should be done is left undone, it should be absolutely prohibited. That gland is still sniffing, and that engineer is still whiffing, and probably to-morrow I will find the same state of affairs. Let an engineer keep his leisurely contentment for his own vine and fig tree, and bring with him to work his alertness and energy and general lively anxiety for the safety and proper working of the valuable machinery committed to his care. The chances are that his engine will run cooler.

Whenever I see O'Type daubing printers' ink on that belt, and screwing up that tightener, I am reminded of a saying in Rabelais:

"By robbing Peter he paid Paul, . . . and hoped to catch larks if ever the heavens should fall."

He is driving as much now with a 6-inch belt as he should be getting out of an 8 at that speed and on that little old driven pulley. The belt is strained and hard; the bearing friction on both pulley shafts is too great, particularly on the driven shaft, and the tighter he makes the belt, the greater that friction is, the more power the belt has to carry. The ink makes it tacky for a little while, but gets smooth, hard and glazed in a short time; then its grip on the driven pulley, and the driving pulley's grip on it, is less than ever. More tension is needed; that still further increases the pull needed; that calls for another dope of ink, which further stiffens the belt, and so on, until the whole thing just quits working.

* * *

Yes, I have a theory about the Schwarzkopf Fuchsschwanz boiler explosion. Had it, in fact, before the explosion occurred.

"Electricity?" Not by a long shot. Nothing so mysterious.

"Galvanic action?" That's merely a form of electricity. Never entered my mind.

"Hydrogen gas?" Never heard of any kind of hydrogen but hydrogen *gas*, and never thought of that in connection with the Schwarzkopf Fuchsschwanz battery of boilers nor with any single boiler thereof.

"Vacuum?" Well, that's the wildest guess yet. I've heard of collapsed flues being due to vacuum, and can understand that; but I never knew or heard of a vacuum that would blow a cast iron boiler head seven hundred feet horizontally, and over a 90 foot stack. Guess again.

"Give it up?"

It is my deliberate opinion that the boiler burst just from an old-fashioned case of not being strong enough to stand the pressure. That's all there is to it.

RAPID Transit in New York is, of course, through the urgency of the demand for it, the recent numerous, almost exhaustive discussions of various schemes, and the recently published report of the Rapid Transit Commission, a topic of live interest in the American Metropolis. The route and scheme proposed by the Rapid Transit Commission, have already been made sufficiently public in the daily press. An item of interest to civil engineers is that the engineering staff who will make the surveys and prepare plans for the "West Side" Line definitely determined upon will be headed by Mr. William E. Worthen, whose name will be everywhere recognized as that of a former president of the Am. Soc. C. E. The well-known skill and experience of Mr. Worthen eminently fit him for the position.

On the feasibility of the Scheme the *Engineering News*, one of the ablest engineering papers published in the United States, expresses the opinion that the Commission "has arrived at a very sensible conclusion, one that presents the fewest obstacles to success in a many sided problem." It adds that "the objection that money enough cannot be found to build it is delightfully absurd, coming as it does generally from the advocates of a surface route." The *Engineering and Mining Journal*, another high-class engineering paper, also approves the decision of the Commission and says, "the only opposition to it, so far made known, is in a certain portion of the New York daily press, which is apparently inspired by the present elevated railway company. Of course, none interested in that enterprise could be expected to look with favor upon the new scheme. Engineers are, however, agreed that the elevated railway system cannot be, practicably, extended so as to afford the rapid transit which the city of New York needs. It is futile to argue that capital cannot be found to engage in the new scheme, before it has been presented, or that the plan of a tunnel under the city is infeasible before the engineering features of the proposed line have been decided." The *Electric Engineer* expresses pleasure with the report, particularly in that electricity is the motive power proposed; and thinks "electrical engineers should congratulate themselves that to them the larger portion of the population of New York is now looking for swift and safe travel between home and work." A correspondent of the *Railway Gazette* is in doubt about the feasibility of the underground road. Its construction will, in his opinion, require a degree of care, seldom, if ever, called into requisition. He does not think the difficulties insurmountable, but doubts whether they have all been considered. He makes the point that "some important buildings on lower Broadway, rest on a very wet quicksand." He argues that "if in pushing a tunnel through that material even a small amount is excavated in excess of the volume of the tunnel, such buildings will be endangered. Low ground in places of New York has been filled with masses of rock. If a large building rest on part of a mass and it becomes necessary to break off the other end, he thinks there will be trouble. The *Western Electrician* says the report "is practically a declaration that

the solution of the problem is to be found only in the adoption of electricity as a motive power." With reference to the motive power to be employed, the *Electrical Review* says the report "means of course, simply electricity." The opinion of the *Electrical World* is that the report "is not altogether satisfactory in that it does not give any very clear idea of the working plans that would be favored by the engineers of the commission," but that "nevertheless the proposed scheme is commendable." The New York *Sun*, which has appeared to be on the side of the existing elevated railway company, makes an argument of the general discomfort attending tunnel travel, citing, as supporting its statement of difficulties in obviating such discomforts, the difficulty which the State Railroad commissioners have experienced in deciding upon practical methods of ventilating and lighting the Fourth Avenue tunnel of the New York Central and Hudson River Railroad in New York City. It seems to blink the fact that the discomforts complained of arise chiefly from the use of steam, and coal as the fuel for generating steam. A ride in warm weather through a cool, clean, well-lighted and ventilated tunnel, from which the nuisances of ill-smelling oil, sulphurous gases from coal combustion and blinding dust are excluded, might be a very tolerable experience, and in warm weather, even more desirable than a trip in one of our over-crowded elevated railway cars.

The Route Recommended for the west side of the city substantially accords with the views expressed in Mr. Gribble's articles published in this magazine. The commissioners have abandoned the idea of a viaduct through the blocks and have selected a principal thoroughfare for an underground railway. They have recommended, instead of a deep tunnel, one as near the surface as possible. The argument for co-operation between a surface and a subway road which was strongly urged by Mr. Gribble was not within the province of the commission, for they have no jurisdiction over any surface road. It is a peculiar condition of things that after waiting so long for a cable road, Broadway should be threatened with a double disturbance instead of one. As regards construction, to underpin a substantially constructed cable road by girders without disturbing the traffic would be costly, whereas to make a combined structure would effect a saving in both surface and subway roads and avoid disturbance of the traffic. The depth at which the tunnels are intended to be constructed has not been as yet given in close figures by the commissioners, but they recommend that on the uptown section it should be a subway immediately under the surface, (including provision for pipes, etc.,) but on the downtown section to be deeper. This decision would appear to originate in a desire to avoid underpinning the Broadway cable road which will extend as far as 33d Street and then run into 7th Avenue. It may mean that a deep rock tunnel will be resorted to in lower Broadway for the sole purpose of avoiding cable conduits which are only now building, thus necessitating deeper elevators and steeper gradients, together with a comparatively slow and costly construction.

As Regards Operation: For surface and subway roads to be worked in competition would be to lose the immense advantage of handling two classes of travel by means of transfers, both classes being internal travel. It must moreover be disastrous in the end to the surface road, because the subway would command all the future improvements in motive power whereas the surface road must be forever restricted as to speed.

The Objections which have been raised to any underground system are based upon the consideration of older railways operated by steam, and disregard recent scientific advances. Any one can realize what an electric or cable subway railway might be made by travelling in the horse-car tunnel under Park Avenue in New York City. Imagine it without any smell of horse-manure; without any jingling of bells or banging over rough rail-joints; cool in summer and warm in winter; well lighted and ventilated and furnishing a comfortable and easy transit at a

speed of twenty to thirty miles an hour. The views expressed by the banker, Mr. Jacob Schiff, in the *Sun*, that the cost would be too great to offer a good financial prospect are derived likewise from railways which can be more easily contrasted than compared with the one proposed by the commission. The London underground railway had no straight avenue to run under; it was driven under tall buildings, railway viaducts, etc., whereas the Broadway subway could be constructed from end to end without touching a single building or materially diverting a single pipe. The other work referred to by Mr. Schiff, the *Berliner Stadtbahn*, which required government help in its construction, was a viaduct railway, with very fine architectural features. It was supplied with extensive depots for military purposes in time of war, and it is not to be compared, as to cost, with a subway built on utilitarian principles.

Viaduct Railways exist in London, Paris and Berlin, but in both London and Paris underground railways are in course of construction on a large scale; and in Berlin a similar railway is projected. It is only fair to argue from these two facts, that if European capital is not afraid of underground railway construction where in some cases only narrow, crooked streets exist precisely where they were 300 years ago, it is possible to obtain a better showing in an American city, laid out in a business-like fashion.

The Suggestion that the City Should Borrow the money for construction is worthy of the most careful consideration, but opinions must be expected to differ. Some who have given the subject great consideration are convinced that there is sufficient margin of profit to make the franchise worth paying for heavily by private parties; but if the capital were raised by the city, and the profits could be secured under trust for the city's benefit, and for expenditure in municipal improvements, it would be more conducive to an extension of these much needed facilities throughout the city than if the railway were financed in the ordinary manner.

The Vital Objection to substituting municipal ownership for private investment is of course the danger of corrupt management—a danger, which as the political history of American cities unfortunately indicates, is an ever present one.

The General Committee of Engineering Societies, which is a permanent committee on "International Engineering Congress, and Engineering Headquarters, World's Columbian Exposition, 1893," held a meeting on the 15th May. A large number of engineering societies and clubs were represented. The societies participating and represented at the meeting by delegates or alternates were as follows:

American Society Civil Engineers; American Society of Mechanical Engineers; American Institute of Mining Engineers; American Institute of Electrical Engineers; Engineers' Club of Philadelphia; Canadian Society of Civil Engineers; Engineers' Club, St. Louis; Civil Engineers' Club of Cleveland; Engineers' Club of Kansas City; Montana Society of Civil Engineers; Civil Engineers' Society of St. Paul; Minneapolis Society of Civil Engineers; Engineering Association of the Southwest; Engineers' Society of Western Pennsylvania; Western Society of Engineers. Mr. E. L. Corthell representing the Western Society of Engineers and its president, addressed the meeting, and stated that the World's Congress Auxiliary "is an organization authorized and approved by act of Congress to have charge of all conventions in connection with the Exposition of 1893. This Auxiliary has nothing whatever to do with any material exhibit at that Exposition. Whatever can be seen belongs to the jurisdiction of the Exposition and the National Commission; whatever is to be spoken and heard belongs to the province of the World's Congress Auxiliary." * * * * While the Exposition will exhibit things, we propose to exhibit the world's men—men and their achievements as they are seen in intellectual and moral portrayal." There is to be a non-resident branch, called the Advisory Council of Engineering, the membership of which may be scattered throughout the country and

throughout the world and composed of the most eminent representatives of the engineering profession. This Advisory Council may be composed of twenty or fifty members, as may be desirable, and is to cooperate with the local committee by means of correspondence at all times and by personal conference. The Congresses will be a series (one assigned to each department), the sessions to be from a week to ten days for each, beginning the first week in May, 1893, and ending the last week in October. Adequate places of meeting will be provided with smaller rooms for the accommodation of chapters or sections.

The General Committee of Engineering Societies is the name adopted for the organization. In its report on organization the objects of the organization are set forth, as, first, "to provide on behalf of the engineering societies represented on the committee an engineering headquarters for members of all the engineering societies of the world, who may visit Chicago during the World's Columbian Exposition in 1893. Second, "to promote an International Engineering Congress to be held in Chicago in 1893, under the auspices of the World's Congress Auxiliary of the World's Columbian Exposition." An admirable and judicious selection of officers was made. They are: President, Mr. Octave Chanute; Executive Committee, Messrs. E. L. Corthell, E. M. Izard, Wm. Forsyth, C. L. Strobel, Robt. W. Hunt, Jno. W. Cloud and D. J. Whittemore. A resolution to the effect that the importance of engineering entitles it to the place of an independent department in the World's Congresses as outlined above, was adopted. In its possible and probable influence upon the future of the engineering profession the movement thus initiated is of more importance than any event of recent date.

Women as Assistants in civil engineers' offices, might perform much of the work now done by men. Drawing, plotting, tinting, as well as a large portion of the mathematical calculation, are all within the scope of their physical and mental abilities; and no reason is apparent why they could not also prepare specifications and draw up contracts were they properly trained to the work. That all this is not merely an opinion is proved by the fact that women are employed in the Surveyor General's office at Denver, and it is stated that with two exceptions only (heads of departments) they have been as efficient and have filled as high positions as any of the employés of the office. Other instances might be cited. The experience of educators with girls in mathematical studies has demonstrated them to be at least equal to boys in ability to grasp fundamental principles; and they acquire equal skill in applying principles to practice. There is nothing unrefined or unsuitable to women in the office work of civil engineering. Then why not enlarge the field of woman's work by giving the girls a chance?

The Practical Application of Magnesia Cements is discussed by Dr. Carl Otto Weber in a paper recently read before the Society of Chemical Industry. While admitting that as competing with alumina lime silicates they are entirely out of the question, he has no doubt that such cements might easily find a considerable sale when means are found to overcome certain unwelcome properties which are the main impediment to their use. He states that:

"Magnesia salts precipitated with alkalies yield a magnesia of great hardness, forming cements of a very poor quality, whereas the magnesia obtained from chloride of magnesium by calcination is of great density. To use Deville's method for the production of this cement on a commercial scale is out of the question for economical reasons. But considering the composition of Deville's cement, magnesia and carbonate of lime, it is not surprising that experiments have been made with a view to utilize dolomite, a natural magnesia-lime carbonate, for the manufacture of the product in question. If dolomite is heated to a temperature below red heat, the carbonic acid of the magnesia carbonate, but not of the lime carbonate, is given off and the resulting product is Deville's cement. Grace Calvert found that the hydraulic properties of this cement increase with the proportion of magnesia which it contains, and that in strength and durability it is equal to a good average Portland cement. This standard, however, was subsequently contradicted by Erdmenger. At about the same time Deville made his researches on

magnesia lime carbonate cements, Sorel discovered his magnesia cement, which he described as magnesium oxy-chloride. He produced it by forming a paste from a finely ground magnesium oxide and a solution of magnesium chloride from 30 to 70 per cent. strong. This cement, which sets tolerably quickly, forming a mass, considerably harder than marble, gives extraordinary high figures in the crushing test and possesses a tensile strength equal to nearly one ton per square inch, which is about three or four times the tensile strength of a good Portland cement. It has the further advantages of being fairly cheap, producing splendid concretes with as much as ten times it own weight of indifferent materials, and having a beautiful white color, so that it appears scarcely doubtful that if magnesia is going to win a place among the important cements, it will be in the form of Sorel's cement or some improvement thereon."

Valuable Hints on Drilling Holes in Masonry for putting in foundation bolts are given by Mr. Wm. L. Saunders, M. A. S. C. E., in an article contributed to *Stone*. The article is not confined to this topic but discusses other important practical details of drilling. Drilling holes in masonry is often a perplexing operation, on account of the tendency of the drill to deviate in its direction; and the putting in of a line of straight holes in masonry or concrete is regarded as perhaps the most difficult operation in drilling. On this subject he remarks that the largest drill at hand should be used, no matter what the depth of hole is, because a large drill gives less trouble by sticking, and its force of blow may be regulated by the throttle. It is also advisable to use steel of large diameter—nearly as large as the diameter of the bit. The legs of the drill should be firmly set, and the runner should watch the hole and carefully follow the directions given below, which also apply to rock drilling.

"Where drill holes tend to run out of line the bit should invariably have a straight edge that is at right angles to the axis of the drill steel. In some difficult places where the hole passes through soft spots or seams running diagonally across the hole it is advisable to upset the steel for a distance of about six inches above the bit. In other words, the steel should be very nearly the full diameter of the bit for a distance of about six inches at the bottom. The purpose of this is, that the steel may be caught by the wall of the hole, thus preventing "running" until the pocket or seam has been passed. This is readily understood when it is known that the steel used with percussive drills is usually about one inch diameter octagon with a bit of about two inches and a half diameter, thus there is a space of about three-quarters of an inch between the steel and the drill hole, and should the condition of the bottom of the hole be such as to tend to thrust the bit to one side, it will gradually work the steel up against the side of the hole, and will result in a crooked hole, which will give trouble through binding and sticking. If the bar of steel were nearly equal in diameter to that of the bit, it would, as it were, force the hole to run straight. It will not do, of course, to carry so much weight of steel, hence where trouble is met it is best to upset the steel at the bottom. In the ordinary course of drilling the runner sometimes finds that his hole is going crooked, and without waiting to get a special piece of steel he attempts to pass through the obstruction. The first thing to do is to reduce the speed of cutting. This is done by either throttling the steam or shortening the stroke of the drill by dulling the bit, but whatever is done it is necessary to "go slow" with the drilling. An effective means by which to prevent "running" is to pull out the steel and throw some iron filings, or small pieces of iron in any shape, into the hole; then put in the steel and go ahead. This not only reduces the speed of cutting, but the pieces of iron are thrust into the softer places, and thus the bit cuts through the obstruction and keeps the hole in line. Again a drill hole will sometimes "run" in a most unexpected manner, and in rock of uniform texture. In a case of this kind the runner should at once stop his machine and see if his bit is in good shape. Sometimes one of the flanges breaks off and serves the same purpose in throwing the steel out of line as though a "hard-head" were encountered. If the broken piece is large it will sometimes get in one corner of the hole and give considerable trouble, even after the bit has been repaired. It is of much importance that the hole be well started, that is, it should be started straight. In dimension stone quarries, the mouth of the hole should be preserved at about the diameter of the hole, and not cratered or broken. This can be done by starting with a light blow and a short stroke, lengthening the stroke and the force of blow after the hole has been made a little deeper than the length of the stroke."

The Road Law, as passed by the Legislature of Pennsylvania, as we are advised, has, since the able articie of Prof. Haupt was in type, been vetoed by the Governor on the ground that it was too comprehensive, that the State money was to be used only on the township roads, and that the majority which passed the bill was small. This will continue the annual waste of moneys collected for roads in this State, which is estimated at not less than $4,000,000 for maintenance and at least as much more for wear and tear, thus maintaining a public nuisance detrimental to health and obstructing commerce.

Estimates of the Economy of Gas Engines under varying loads, as compared with the cost of equal power derived from steam-engines under like conditions formed the subject of an extremely interesting and important paper recently read before a meeting of the Western Gas Association, Louisville, Ky., by Mr. E. M. Jenkins of Columbus, Ga. He stated that over 8 per cent. of the gas manufactured at the Columbus gas-works is sold for power purposes, and that the comparisons of cost given in his paper, were made upon the basis of $1.25 as the price of 1000 cubic feet of gas (the rate at which gas is sold in Columbia) and the average price of steam coal at that point which is $2.50 per ton. We abstract two of these comparisons which certainly seem to be fairly made. It will be seen that for small amounts of power and variable service they are highly favorable to gas motors. It should be added that the estimates are stated by Mr. Jenkins to be the actual result of each gas-engine computed on a ten-hour basis. With intermittent use of power the results ought to be still more favorable for the gas motors.

Four H. P. Steam Engine, Seven H. P. Boiler —Ten Hours Per Day.

Coal, 500 pounds, at $2.50 per ton,	$0.62½	
Labor	.25	
Oil, waste and repairs	.12½	
Water, 350 gallons, at 15 cents per M	.05¼	
Extra insurance, one-half of 1 per cent. on $4000	.06¼	
Total, per day	$1.12	
Per month, 26 days	$29.12	
Per H. P. per month		$7.28

Gas Engine (No. 3), Four H. P., Ten Hours Per Day.

Monthly average per H. P. for gas, at $1.25 per M	$3.90	
Oil and waste	.60—	$4.50
Saving per H. P. per month		$ 2.78
Saving per year four H. P.		133.44

Seven H. P. Steam Engine, Ten H. P. Boiler— Ten Hours Per Day.

Coal, 700 pounds, at $2.50 per ton,	$.87½	
Labor	.50	
Oil, waste and repairs	.15	
Water, 500 gallons, at 15 cents per M	.07½	
Extra insurance, one-half of 1 per cent. on $5000	.08	
Total, per day	$1.68	
Per month, 26 days	$43.68	
Per H. P. per month		$6.24

Gas Engine (No. 1), Seven H. P.— Ten Hours Per Day.

Monthly average per H. P. for gas, at $1.25 per M	$3.25	
Oil and waste	.60—	3.85

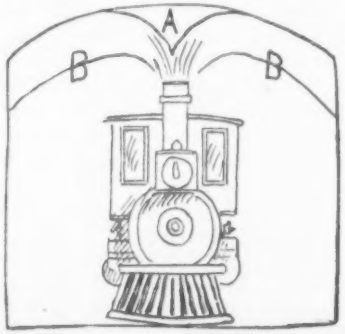
Gas Engine (No. 2), same as above.

Monthly average per H. P. for gas	$3.co	
Oil and waste	.60—	3.60
	$7.45	
Making average for the two engines		$3.73
Saving per H. P. per Month		$2.71
Saving per year seven H. P.		$227.64

Rapid Transit in the city of Berlin is described in the *Street Railway Review* for June in a very agreeably written article by Mr. T. Graham Gribble, whose name will be immediately recognized by our readers as the contributor of the important articles on Rapid Transit published in our May and June numbers. The article is also beautifully illustrated, the construction of the bridges over the streets and the methods adopted in their construction forming subjects of illustration and description. The article is to be continued. As it contains a great deal of valuable information on the subject of rapid transit in cities, and as there are few writers contributing to technical journals of Mr. Gribble's acknowledged ability, we feel justified in specially calling the attention of engineers to it.

The Death of Col. John Albert Monroe on the 11th inst., which occurred in Providence, R. I., will be regretted by a very large circle in the civil engineering profession, to which he belonged. Colonel Monroe commenced his education at Brown's University, but left that institution to enter the service of the United States at the outbreak of the Civil War. He was made chief of artillery in McDowell's and Doubleday's Division, and Hooker's Corps. He served in various capacities with distinction throughout the war. When the war closed he adopted the profession of civil engineering, and was identified with important works in all parts of the country. In 1879 he was appointed United States Assistant Engineer under the Mississippi Commission, and made complete hydrographical, topographical and geodetic surveys of the river from Cairo to Memphis. His later work has been in construction of a section of the West Shore railway.

The Ventilation of the Fourth Avenue Tunnel in New York City is to be attempted under a plan adopted by the State Board of Railroad Commissioners in concert with the officers of the New York Central and Hudson River Railroad, and of the New York, New Haven and Hartford Railroad. The diagram, which is a cross-section of one of the single track tunnels, illustrates the method which is to be applied. Those familiar with this tunnel will know that it consists of three parallel tunnels included under the single appellation "tunnel," the outer ones having each only one track, while the middle one has two tracks. A second roof is to be constructed below the real roof of the tunnel with an opening in the middle to run the entire length of the tunnel, thus dividing the space between the two roofs into two long chambers. The opening in the lower roof will come just above the smoke-stack of the locomotive. Over this opening there will be suspended from the upper roof a V-shaped deflector, also running the entire length of the tunnel. It is intended that the smoke and cinders as they rise from the smoke-stack shall be thrown into the chambers on either side of the deflector. Through the chambers a strong current of air will be made to pass in a direction opposite to that of the passing train, driving the smoke out through the existing openings into Park Avenue, and keeping the atmosphere of the tunnel clear. The cinders that will accumulate in the chambers will be cleaned out from time to time. We hope that the expectation that the nuisance of cinders and smoke in the tunnel will be removed by the application of this device, which is to be put in operation experimentally between 56th and 67th Streets as soon as possible, may be realized. However, we are forced to doubt the feasibility of the method. We anticipate that the blast which is expected to force the smoke and steam through the openings in the now existing roof of the tunnel will be liable to force it downward through the longitudinal midwise opening back again into the tunnel space. The experiment will demonstrate whether this anticipation is well founded or not. Without doubt, the officers of the road who have all along maintained that the ventilation and lighting of this tunnel were impracticable, will not be displeased if failure result. Some engineers with whom we have conversed have been so uncharitable as to suggest that the probability of failure was the secret of the promptness with which the work was decided to be put in hand. If this suggestion has any foundation, it is that failure of the plan adopted together with the numerous absurd schemes that have been pressed upon the attention of the Commissioners would fortify the opinion expressed by the railroad officials.



AS Related to the Heating of Buildings as well as to many other things of importance in connection with the comfortable management of a building after its erection a good, capacious well-constructed cellar is of great importance. Architects are sometimes led to believe that a contracted, small excavation, or perhaps two or three such excavations under a large building afford all the necessary facilities for heating it; they are often assured of this by solicitors for heating contracts, and are thus led to consent to such a construction without duly weighing what may happen after the building is erected. An instance in point is recalled by the writer. An estimate was requested for putting in a heating apparatus in a church which had been erected some years, but in which the heating had never been satisfactory. Upon visiting the premises to make a survey, it was found that only two small excavations had been made, one at each end of the building. In each of these excavations had been placed three hot-air furnaces. These furnaces were connected with chimneys at long distances with so little head room that no inclination could be given to the smoke pipes, and consequently their draft was very deficient. After an attempt to heat the church by the use of these furnaces was found to be futile, they were assisted by two small steam boilers, one in each of the excavations. The space between the floor of the church and the ground was too little to run the steam pipes under the floor, and it could not be excavated, as it was solid rock. The running of the pipes over the floors in order to avoid the obstruction of the aisles and doors was an extremely difficult operation, and they were necessarily so run that the expansion and contraction soon distorted them out of shape, trapping supervened, and consequent obstruction of circulation resulted. The writer, after a short inspection of the premises, withdrew and declined to make any estimate on putting in a substitute for the old heating apparatus. Now here was an instance wherein to save the expense of excavating the rock, a total and permanent failure to properly heat and ventilate the building resulted. Inquiry into the history of this case brought out the fact that the architect who originally planned the building, desiring to save the owners all the expense possible, and being convinced by a contractor who wished to put in a heating apparatus that it could be effectually done in the manner above described, was led into the fatal error of not providing a sufficient excavation below the building for the purposes named. No building in which heating and ventilation are contemplated or necessary should ever be erected without ample basement or cellar room for the supply of any heating and ventilating apparatus which may be found to be needed. For very large buildings like the church referred to, the cellar should extend under the whole of the building.

The Monier Arch as now constructed and used in Germany and other parts of Europe is attracting considerable attention in engineering and architectural circles. The principle of construction in this arch is exceedingly ingenious and there can be no doubt that, especially in arches with low spring, a degree of strength can be obtained for a given weight of arch very far exceeding that hitherto obtainable. The vital feature in this construction is that

wires are inserted in the concrete from abutment to abutment near the soffit. The wires become solidly and adherently joined to the cement, thus largely increasing the tensile strength of the lower part of the arch. It is understood that the system is not yet considered to have reached perfection, but there can be no doubt that the principle is sound and that its adoption by progressive engineers and architects may result in obtaining equal strength with much less material than has hitherto been required.

The Cooper Union is a building in which the struggling classes of New York and their sympathizers take more interest than any other. It represents the spirit of its founder as much or more than any other institution in the city. On our table is a report of the Trustees relating to the work done for the past year. The building is being enlarged and rendered more commodious by the reconstruction of the two upper floors in order to provide ample accommodations both for the day, and night Art School. The outlay required for this enlargement is about $100,000. The children of Mr. Cooper (Mr. Edward Cooper and Mrs. Sarah A. Hewitt), have given their assurance to the Trustees that they will make good any deficiency of the ordinary income which might occur from the expenditure required for the enlargement, and an ample provision of additional income for defraying the expense of a greater number of pupils has been acquired through an endowment under the provisions of the will of the late Daniel B. Fayerweather, which appropriates a sum of $200,000 as an endowment fund, "to be forever kept separate and apart for the support of the Art School for Women." It is impossible in this connection not to mention the beautiful tribute paid to the memory of Mr. Peter Cooper by the Hon. Seth Low, President of Columbia College, in an address delivered at the centennial anniversary of Mr. Cooper's birthday, on the 12th of February last.

Mr. Low said:

"The men of this generation know well that Peter Cooper was a great philanthrophist; they do not know so well how remarkable a man he was in other directions. Neither his philanthrophy, nor the financial ability to manifest it by princely gifts were accidental. Both alike represented the fruition of a patient purpose steadfastly pursued through long and laborious years. It is a true instinct which leads men from time to time to review the story of such a life, for such lives minister to that which is best within us, as the rain refreshes the earth."

A Colored Photograph printed directly and entirely from negatives has been exhibited in London. The picture has been produced by a process devised by Mr. F. Bligh Bond, Secretary of the Bristol and West of England Amateur Photographic Association. It is a view of Land's End, and is described in English papers as a chromo-collotype, printed in blue, carmine and yellow, from a set of three negatives, which it is claimed have undergone no retouching or manipulation beyond the chemical development. The principle involved is the selection of the colors of nature in the negative and their recombination in the print. The photograph, which is dated August, 1890, is said by the London *Court Journal* to be a charming little picture. The coloring of the rocks and the sea is especially remarkable for its naturalness and beauty, while the blending and shading of the tints are characterized by the utmost delicacy. Mr. Bond, who is an architect by profession, appears to have more nearly reached the practical solution of photography in colors than Prof. Lippman of the French Academy of Sciences, who, as stated in this magazine for April, is also working upon it.

A New White Granite, recently discovered at Barre, Vermont, appears to possess valuable qualities for building, and it would seem, from a brief description of it by a correspondent of *Stone*, to be a fine material for artistic treatment. He says it was found in the centre of a territory in which the light and dark blue Barre is found, but seems to be of an entirely different formation. It is very hard (more so than the blue Barre) and takes a fine polish. The hammered parts are so very white that it is expected to largely take the place of marble. Trace work and lettering show very distinctly. The deposit covers about ten acres.

The Cost of Concrete and Masonry are so frequently the subject of estimate on the part of architects and engineers, that a comparison of some of their estimates with the cost of various kinds of concrete and masonry, as obtained from actual expenditures on the power station of the electric railways of Pittsburgh, Pa., will be interesting and instructive. These statements of cost are condensed from the *Polytechnic*. The cost of 840 cubic yards of concrete for foundations of the walls, boilers, chimneys and engines, and also for the cellar floor, is as follows:

Portland Cement	1.28 bbls.	at $2.60	$3.33
Sand	0.50 cu. yd.	at 1.30	0.65
Broken Stone	0.90 cu. yd.	at 1.25	1.12
Labor	0.91 day	at 1.75	1.59
Foreman	0.07 day	at 3.00	0.21
Total Cost of a cu. yd. of concrete, in place			$6.90

The cost of rubble masonry for cellar walls and boiler foundations built of sandstone blocks of moderate size is as follows:

Sandstone (purchased)	1.00 cu. yd.	at $2.50	$2.50
Louisville cement	0.64 bbl.	at 1.25	0.80
Sand	0.32 cu. yd.	at 1.30	0.42
Mason	0.37 day	at 3.60	1.33
Common labor, unloading stone, mixing mortar, etc.	0.36 day	at 1.75	0.63
Total cost of a cu. yd. of masonry			$5.68

The pier of the chimney, 16 x 16 x 9 ft. containing 58⅓ cubic yards, built with stones of about the same size of those used for the cellar walls except for the footing and coping courses in which larger stones were used, is:

Sandstone	0.78 cu. yd.	at $2.50	$1.95
Sandstone	0.22 cu. yd.	at 4.50	0.99
Portland Cement	0.68 bbl.	at 2.60	1.77
Sand	0.30 cu. yd.	at 1.30	0.39
Mason	0.23 day	at 3.60	0.83
Common labor, unloading stones, mixing mortar, etc.	0.48 day	at 1.75	0.84
Totol cost of a cu. yd. of masonry, under chimney			$6.77

The cost of brick-work for the walls, which are 18 inches thick and 25 feet high from the top of the stone masonry which supports them to the bed plates of the roof and have pilasters projecting 4 inches from the face of the wall at intervals of 21 feet, is:

Red bricks	465 at $7.50 per 1,000		$3.49
Quicklime	0.40 bbl.	at $0.50	0.20
Sand	0.28 cu. yd.	at 1.30	0.36
Bricklayers	0.41 day	at 4.50	1.84
Helpers	0.52 day	at 2.00	1.04
Total cost of a cu. yd. of brick masonry,			$6.93

The cost of the engine foundations which consist of five separate piers, three of them supporting two Corliss engines of 600 H. P. each, and the other two supporting two engines of 300 H. P. each, is:

Red bricks	470 at $7.50 per 1,000		$3.52
Portland cement	0.59 bbl.	at $2.60	1.53
Sand	0.26 cu. yd.	at 1.30	0.34
Bricklayers	0.24 day	at 4.50	1.08
Helpers	0.34 day	at 2.00	0.68
Total cost of a cu. yd. of cement brick masonry			$7.15

The cost of the brick masonry for the chimney, square in section, 125 feet high, with a batter of three inches in 10 feet from a height of 36 feet from the ground, and the walls of which vary in thickness from 27 inches at the base to 13 at the top, and have a fire-brick lining extending 36 feet above the grate with flue 9 x 9 feet, is as follows:

Fire-bricks	25 at $14.00		$0.35
Fire-clay	0.10 bbl.	at 0.90	0.09
Red bricks	465 at	7.50	3.49
Quicklime	0.30 bbl.	at 0.50	0.15
Sand	0.22 cu. yd.	at 1.30	0.29
Bricklayers	0.30 day	at 4.50	1.35
Helpers	0.47 day	at 2.00	0.94
Coal for hoisting engine	60 lbs. at $2.25 per ton		0.06
Engineer	0.09 day	at $2.50	0.22
Total cost of a cu. yd.			$6.94

It may be added that this chimney consumed in its construction 193,200 bricks, of which 9800 were fire-bricks. The cost

of setting the boilers, 10 in number, and divided into two sets of five each, was:

Fire-bricks	105	at	$14.00	$1.47
Fire-clay	0.50 bbl.	at	0.90	0.45
Red bricks	365	at	7.50	2.74
Quicklime	0.25 bbl.	at	0.50	0.12
Sand	0.17 cu. yd.	at	1.30	0.22
Bricklayers	0.63 day	at	4.50	2.83
Helpers	0.66 day	at	2.00	1.32
Total cost of a cu. yd.				$9.15

This boiler setting consumed 222,000 ordinary bricks and 33,800 fire bricks. The labor estimated is made on the basis of ten hours per day.

Interesting Scientific Tests of compound ventilating wheels have recently been made by the Barney Ventilating Fan Company, manufacturers of these wheels, at 70 Pearl Street, Boston, to ascertain the ability of each wheel when used for the removal of vitiated air, steam, etc., at an increasing speed of twenty-five revolutions per minute from the minimum, the horse power required to develop these speeds, and the power of each fan under plenum or exhaust. So far as we are aware, such a series of tests has never been carried out before in such detail. The method adopted seems entirely reliable. A case was made for each wheel of about the same diameter as the wheel and not less than three times the diameter of the wheel in length. The wheel was applied at one end of this case, and was operated by power transmitted from an electric motor through a pair of cones made for the purpose, which were used to obtain the exact speeds required. To obtain the horse power transmitted from the motor, an Emerson dynamometer was applied directly to the shaft of the wheel. The velocity of the column of air which passes through the wheels was obtained by an anemometer held in the end of the case furthest from the wheel, and so manipulated that at a regular speed it was made to pass before every point in the sectional area of the case once in one minute. This manner of obtaining the average velocity was found necessary for the reason that the discharge of air was found to be greater in some portions of the sectional area than in others, and although much greater readings could have been obtained by holding the anemometer in the most advantageous position, still, it would not have given a fair idea of the average velocity in the case. The averages thus obtained and the sectional area of the case were factors from which the volumes were deduced. After the completion of each measure of volume and the horse power required to obtain it in free circulation, the end of the case where the anemometer was manipulated was closed air-tight, and the fan again started and made to blow into this air-tight receptacle. This is obviously the hardest work that a fan can ever be called upon to do and is the extreme of the same kind of labor performed by this kind of mechanism when blowing or exhausting under the bed of a wool dryer or through long ducts. The horse powers required to do this work at different speeds were noted, and the pressures developed were registered by a Sturtevant pressure gauge. This ended the special test for each wheel. The calculations required to obtain the results from the data thus obtained covered more than 40 large pages of the most condensed figuring, and the volume tables are to be printed in a circular now in press which the firm named inform us they will send to architects and others interested, upon application. The extent of these tables precludes our printing them in this department.

An Architectural Problem that before many years elapse will confront New York Architects, must arise from the development of the lower part of the city. It may seem singular to speak of development as connected with the older end of the city, but it is literally correct. This part of the town finding its room too scanty, has grown skyward until the streets can no longer comfortably accommodate the traffic the tall buildings bring into them. Something will have to be done. Side-walks for foot-passengers on the level of the second story, or arcades built through the first stories seem the only ways by which the entire original widths of the streets can be utilized for vehicles. In many of the lower streets the trucks now encroach largely upon the side-walks.

ELECTRICITY as Applied to Modern Warships is an interesting subject appropriately following upon what we said in our June number concerning electricity in warfare. It appears from the London *Electrician* that eight vessels have been recently built and armed at Elswick, England, and each provided with an electrical outfit. Of these, three are colonial cruisers, the *Katoomba*, *Mildura* and *Walaroo*. Each of these cruisers has an electric light installation of 257 16-candle-power and 37 50-candle-power lamps. Two yard-arm reflectors, each containing 8 50-candle-power lamps and 2 semaphore signalling arrangements are supplied to each of the vessels. These signalling apparatuses each consists of a box fitted with a powerful reflector by which the two movable arms of the semaphore are illuminated from the light of 4 16-candle-power lamps. Each vessel has also 3 search light projectors. The generating plant consists of two sets of "Willan's" engines and "Siemens'" dynamos, having a speed of 415 revolutions per minute, and supplying 300 amperes at a pressure of 80 volts. The torpedo tubes are also fired by electricity, and two alternative methods of electrical firing are applied to eight 4-7 in. quick-firing guns, which each of the cruisers carries. Four smaller colonial war vessels are not lighted internally by electricity but each carries an 80-unit "Siemens" dynamo to supply current to a search light projector, yard-arm reflector and semaphore reflector. Each carries 5 torpedo tubes fired electrically from the conning tower and each also carries 2 4-7-in. guns which are electrically fired. The other one of the eight ships referred to has an electrical outfit of 3 Parson's steam-turbine, 16-unit dynamos by which the yard-arm reflectors, search lights, 190 16-candle-power lamps and 12 50-candle-power lamps are supplied with current. This ship also carries 2 21-centimeter guns and 8 4.7-in. guns. When these guns are used at night, small incandescent lamps are used to illuminate their sights. The system of wiring is that known as the double wire system, the cables being lead cased.

The Annual Meeting of the American Institute of Electrical Engineers, held the latter part of May, was a very successful convention. There was a large attendance and a great many excellent papers were read. Alexander Graham Bell, inventor of the telephone, was elected president, and Mr. T. D. Lockwood, Mr. O. T. Crosby, Mr. Carl Hering and Mr. W. J. Hammer were elected vice-presidents. Space will not permit a notice of these papers at length. The one which would probably most attract the attention of the lay portion of the audiences was that of Mr. Nikola Tesla upon "Alternating Currents of Very High Intensity." These experiments were exceedingly brilliant, owing to the employment of large sized Geissler tubes which were beautifully illuminated. The experiments were entirely out of the common, and the effects of high frequency in alternation were very impressively displayed. Researches in this field may lead to important practical results. The discussion of the electro-magnetic vibrations of the ether and the production of light by electro-static effects is too abstruse for place in this department.

The Contract for the Electrical Building of the World's Columbian Exposition has been given out, and it is announced that the construction will be soon commenced.

There is a general expression of regret that many essentials to the success of the electrical exhibition are by this action rendered impossible. However there is but little doubt that the electricians who desire to make exhibits will, to use a common phrase, "pull themselves together" and get along with more limited facilities than they hoped to obtain. It is stated that a very large number of requests for space have been already made.

The Incandescent Lamp Suit has been a theme of discussion in all the electrical publications during the past month. The magnitude of the capital involved and the large amount of capital represented by the complainant, together with the nice points which will have to be adjudicated, will render this case historical among electric patent litigations. As one electrical journal very pertinently puts it, the case is one of "Edison against the field." If he succeeds in his endeavor he will secure a monopoly of the manufacture of electric lamps for his company. The defense relies upon the previous state of the art and the lack of patentable invention in Mr. Edison's patent to establish its invalidity. A large amount of testimony has been taken and neither party to the suit will be likely to relinquish its contention until the Court of highest resort shall have passed upon it.

The Massachusetts Municipal Lighting Law is said to be the first enacted by any of the United States legalizing the municipal ownership of gas and electric light plants. On this account it is attracting attention and it is liable to be used both as a model and a precedent for similar legislation in other States. The Act contains seventeen sections. The first section empowers cities or towns, under certain limitations, to purchase or lease real and personal property for the purpose of establishing plants for the manufacture or distribution of gas or electricity for municipal use and for the use of their inhabitants. The second section restricts the exercise of the authority conferred in the Act to cities in which the city council, by a two-thirds vote approved by the mayor and subsequently ratified by a majority of the voters present and voting at an annual municipal election, shall express the desire to establish municipal control of lighting. When such a vote has failed to secure the desired ratification no similar vote shall be submitted until after the expiration of five years. In order to exercise the authority conferred in the first section, towns must approve the expediency of such exercise by a vote of not less than two-thirds of the voters present and voting at each of two legal town meetings duly called for the purpose and held at an interval of not less than two, or more than thirteen months after the first. The votes must be taken by a written or printed ballot. Section 4 authorizes the issue of bonds at 5% interest, to be sold at par and accrued interest, with other similar provisions. Section 5 provides for the enlargement of plants, the course of procedure being the same as that of their initiation. Section 6 provides for assessments upon owners or occupants of premises for part or the whole of the cost of laying and maintaining upon such premises pipes, conduits, conductors, etc. The payment of such assessments is not obligatory, but it may be exacted before providing the appliances. Section 7 empowers cities or towns having obtained a plant to make regulations for the furnishing of pipe for municipal use or the use of inhabitants. Section 8 enacts that the management of such plants shall in each city or town be entrusted to one officer who shall be known as "Manager of Gas," Manager of Electric Light," or "Manager of Gas and Electric Light," according as a plant for one or both may be under his charge. The compensation of the manager shall be annually fixed by the city council and in towns by the selectmen. The manager is also required to give bonds, etc. Section 9 provides that books of accounts shall be kept and an annual report made on or before the second Wednesday of September in each year, stating the financial condition of the business, amount of indebtedness, etc. Section 10 enacts that the price to be charged for gas or electricity shall not be changed oftener than once in three months; that any change shall take effect on the first day of a month, and that

before any change shall take effect it must be advertised in a newspaper published in the city or town where the plant is located. It also provides that the price shall not be fixed at less than cost inclusive of operating expenses, interest on investment, etc., less any assessments which may be collected under the provision of the 6th Section. Section 11 empowers cities and towns to pass ordinances imposing penalties to protect its plant and control its use and prevent accidents. Section 12 contains an important provision, to wit, the cities or towns are required to purchase any gas works or electric works existing within their limits that the owners wish to sell, and to pay the fair market value for such property; but no city or town is obligated to buy apparatus or appliances covered by letters patent, unless a complete right to use the same shall be assigned or granted at a cost as low as the cost of such right would be to the person, firm or corporation, whose plant is purchased. If differences in establishing the market price of the plant to be purchased arise, Section 13 provides that a commission may be appointed by the Supreme Court to adjudicate upon the differences. An appeal from the decision of the commissioners may be made by any party aggrieved to the court appointing the commission and Section 14 provides for a trial of the grievance before such court, the decree of which shall be final and binding. Section 15 provides that the powers and rights of any persons or corporations relating to the manufacture and distribution of gas and electricity shall cease and determine from and after the date of the acquirement of their plants by the city or town in which they are located. Section 16 makes cities and towns responsible for accident and damage to persons or property in the same manner as private owners and corporations are under the existing statutes. Section 18 establishes and limits rights of revocaand restriction.

The Application of Electricity to Welding pipes, if it can be made conveniently applicable to pipes of all sizes or even to pipes of sizes most commonly used, may be destined to work an almost complete revolution in the pipe fitter's art. At present the use of pipe fittings into which the pipes are screwed at junctions, involves not only the cost of the fittings but a considerable amount of labor, and labor of a severe kind. If positively gas-tight joints under high pressure are desired, as in fitting pipes for ammonia refrigerating plants for example, special fittings of a costly kind are needed. Tinning the ends of the pipes, and after they are coupled together, the soldering of the joints to ensure absolute integrity has also of late years been much practised. Where a sufficient electric current is attainable it is now practicable to weld the joints of moderate sized pipes *in situ*, and thus obtain a perfect junction without any fittings whatever, and without the heavy labor attending methods of fitting hitherto employed. But as at the present time a good deal of this kind of work has to be done where electricity in quantity is not obtainable, it might be desirable and profitable in executing large jobs to have a special portable electric welding apparatus. So far as we know such an apparatus has yet to be supplied. Ranks of pipes are now welded by forge heat for large ammonia refrigeration condenser-tanks and ice-tanks for ice factories, and after welding are hoisted and let down into the tanks all with much labor in handling. By welding them electrically they could be handled singly and joined together within the tanks with very much less labor.

The Future of the Aluminium Problem from the chemical standpoint is the subject of one of the ablest papers which has been presented to the scientific world this year. It was read by Dr. William H. Wahl before the American Society of Electrical Engineers on the 21st of May. In his paper Dr. Wahl quotes the opinion of Richards, as expressed in a lecture before the Franklin Society to the effect that although electrical processes are "on top" at present and he thinks will stay there for some time to come, he is far from considering that they may not possibly be superseded by non-electric methods of production. Dr. Wahl regards the reduction of alumina by

carbon as "simply performed by temperature," a temperature "probably not far above the fusion point of alumina;" but he adds that unfortunately for the practicability of the direct reduction processes, this temperature point "lies enormously high, so high, indeed that it does not admit of instrumental measurement, but can only be approximately estimated as somewhere between 2000° and 2600° C.—a point which cannot be reached save by the intervention of electric heating." He thinks there is hope that a chemical process may be based upon the solubility of alumina which he states we have reason to believe may be effected by the fluorides of the alkalies and the alkaline earths. He mentions the fact that there are also other compounds into which alumina enters that are soluble in the proper menstrua. The closing paragraphs of Dr. Wahl's paper are so eloquent that we quote them *verbatim*.

"Briefly summarized the case stands thus:

"The processes in which electricity is applied, either for the direct reduction of aluminium by electrolysis or as the agency for producing the heat required to effect its reduction by chemical reactions, have outstripped the metallurgical methods in the race for supremacy and have taken a decided lead.

"Within the past two years the metallurgical processes as represented by the improved methods of Castner, Netto, Grabau, and others of less renown, have been forced to abandon the field to the electrical methods of Hall, Minet, Cowles and Herault.

"In one brief lustrum to have overtaken and gained the mastery—though it should prove to be but temporary—over a champion so redoubtable as the chemist, who has been striving for the glittering prize through half a century of toilsome progress and indifferent success, is an achievement of which the electrician may well be proud. It behooves him, though, to look well to his freshly earned laurels, for his victory will stimulate his rival to renewed exertions.

"But let our sympathies incline this side or that, if the outcome shall be—and I am persuaded it will speedily be—the final solution of the aluminium problem, we may rejoice in common, for in the victories of peace the vanquished share with the victors in the spoils of the battle."

An Immense Electrical Manufacturing Plant is to be constructed by the Detroit Electrical Works on a tract of 16 acres of land in Detroit, Michigan. Upon this plot is to be erected one of the most extensive electrical manufacturing works in the country, in addition to the present plant of the company already in operation, which is not however to be discontinued. The cost of the contemplated buildings is estimated to be from $200,000 to $300,000, including machinery. Plans and specifications are in such a stage of progress that work is expected to be commenced in July and the entire plant is expected to be constructed and ready for use by June 1st. These stupendous facilities will, it is understood, all be applied to the construction of the American standard type of railroad locomotives hitherto manufactured by the Detroit Electrical Works. The demand for these motors is so great that the facilities of the company are now overtaxed, and the works are running on three hours overtime.

An Electric Organ in which the sound shall be produced by electricity and which shall have neither bellows, sound boards, nor pipes, is the conception of Mr. Hope Jones of Liverpool, as stated by him to the College of Organists. Mr. Jones has already constructed an electric organ in which the ordinary stop knobs are abolished, the stops being operated by electric knobs. This feature of electric organs is not new but a "transposing switch," by which the music as it is played can be instantly transposed to a higher or lower key by the action of electricity is a decided innovation devised by Mr. Jones.

A New Method of Organic Analysis has been performed by J. Oser, who has worked out a process described in the London *Electrical Review*. This journal calls it an "electrothermic" method of organic analysis. For the benefit of unprofessional readers it may be stated that elementary organic analysis proceeds upon the method of converting the substance to be analyzed into solids and gases by the action of heat. The gases are absorbed by re-agents for which they have an affinity, and their several amounts are thus determined. The solids are then made the subject of quantitative chemical analysis and

thus all the elements entering into the substance are determined. Mr. Oser's method does not differ in principle from that described, but instead of using the ordinary appliances for effecting the combustion, he uses an ordinary hard combustion tube, in which a small porcelain dish surrounded by a coil of thin platinum wire is placed. The porcelain dish contains the substance to be analyzed. Pure oxygen is caused to flow through the tube and at the same time the porcelain dish is heated to redness by passing an electric current through the coil. Insulation of the wires leading from the coil out of the tube is effected by small porcelain blocks or cylinders with narrow slits or apertures through which the wires pass. The products of the combustion, together with any excess of oxygen are passed from the combustion tube through granular copper oxide heated to a high temperature by an electrically ignited platinum wire. Oser is said to be making an attempt to devise a single apparatus that will determine the heat of combustion of any given organic substance at the same time that the elementary analysis as described is performed.

The Mexican Telephone and Telegraph Co. have obtained concessions from the Mexican government for a term of twelve years, the privileges thus obtained being so broad as to practically inhibit any attempt at competition. Its condition is very favorably reported. A settlement of the claim of the American Bell Telephone Company against it has been effected, as well as its Mexican indebtedness, and the company begins its fiscal year with no unpaid claims against it and with a surplus in its treasury. The patents owned by the company have been passed upon and sustained by the Mexican courts of highest resort, and everything seems now to tend towards the prosperity of the enterprise. Iron poles costing but little more than half as much as wooden poles are to be erected in the principal streets of the City of Mexico. The change of condition in the affairs of the company is a good portent for the progress of electrical engineering in Central America. The proximity of Mexico to the great railway and electrical enterprises of the United States must ultimately have its due effect, and infuse some of the spirit of progress into the hitherto inert character of that nation.

An Improvement of the Terminals of Fuses for cut-outs has been invented by Sir David Salomons, who has communicated it to the *Electrician* for publication in order that no one else may patent it, the intention evidently being to give the invention to the public. The trouble with the tin wire usually used (which is good because it melts easily and promptly, and is not injured by oxidation) is, that in applying the screw heads or clamps the metal is too soft to resist the pressure. Eyelets have been used, but the screws do not always fit the eyelets, and the necessity of the complete removal of the screws in making connections is another objection. Sir David Salomons' improvement consists in furnishing the ends of the tin wire with clamps of sheet copper having a thickness of about 15 mils. A large surface contact is thus obtained, and a slotted hole renders the removal of the copper contact piece very easy, as it is necessary to turn the screw only very slightly back to release it.

A Peculiar Phenomenon has been described by Dr. Haussknecht of Berlin as accompanying the manufacture of solid carbon dioxide when the latter is carried out on a large scale. The phenomenon is a remarkable development of statistical electricity which seems to be generated on a principle similar to that of the operation of Sir William Armstrong's hydro-electric machine. In the production of solid carbon dioxide the gas is compressed and refrigerated simultaneously until it assumes the liquid form. Then when a portion of the liquid is allowed to expand into gas by allowing it to flow through an opening in the receiver which contains it, the absorption of heat from the liquid to supply the demand for the latent heat of vaporization in the gas is so great that part of the escaping liquid is frozen and thus solidified into a mass resembling snow. The pressure at which the liquid issues is generally from

60 to 80 atmospheres and the "snow" is caught in a stout canvas bag where it becomes compacted. Dr. Haussknecht observed that, when this operation was performed in the dark, the whole canvas bag became illuminated with a greenish-violet light. It is stated that unless the carbon dioxide is absolutely freed from admixture of air, the experiment will not succeed; and also that carbon dioxide artificially prepared secures much better results than that obtained from natural water on account of the fact that the latter almost always contains air. Luminosity begins when a course of the solidified dioxide has been deposited to a thickness of a little over 5 centimeters. Dr. Haussknecht thinks the phenomenon arises from the violent friction between minute liquid globules and the snow-like mass as the former are violently projected against the latter.

A Most Appropriate Application of an Electric Railway System would be in the novel method of coast defense for England, proposed by Lieut. Girouard of the Royal Engineers. It is a system of railways carrying gun-carriages which can be moved on the tracks either to disperse or concentrate fire upon hostile forces endeavoring to effect a landing. The scheme seems to be feasible, as it has been proved by practical trials that 6-inch breech loading guns weighing 5 tons may be safely fired from a railway when pointed at right-angles from the track. Lieut. Girouard recently read a paper upon the subject before the Royal United Service Institution, which has been favorably received by high engineering authorities. It will be remembered that England has been more than once invaded by troops landing at undefended parts of her coast. In this way the famous Dutch Invasion under William of Orange was effected at Torbay, on Sunday the 4th November, 1688; and though this invasion proved a supreme blessing to England in her then unhappy condition, the possibility of such an invasion by hostile forces still exists at various parts of the coast, and it is not regarded with satisfaction. The general features of the scheme are the dividing of the coast into nine sections and the construction for each of a special line of railway upon which the guns are to be carried and operated. By applying to this scheme a system of electric propulsion, every car upon which a gun should be mounted would be ready for instant and independent action without any notable increase in weight, and the mobility and effectiveness of the arrangement would be vastly increased as compared with what would result from the use of steam. So far as we have seen the discussions of the proposition in English papers, the propulsion of the cars carrying the defensive artillery has received little attention, consideration being given mostly to the general features of the scheme, in which, if ever adopted, we predict electricity will play an important rôle both for propulsion and the performance of other obvious functions.

Electric Railway Innovations are the order of the day. In May the establishment of a freight and express service on the electric street railway at Seattle was chronicled. On other roads special cars are provided for theatre parties and even for funerals. The latest social use of the electric car hails from Cleveland, where one of the handsomely equipped Short cars has been utilized for the celebration of afternoon tea-parties. While the guests are enjoying the cup that cheers, they skim lightly and smoothly on the wings of electricity through the green avenues of Cleveland. It is also reported that the same car has been used for a house-hunting expedition by one of the officers of the company. A thorough inspection of all the surburbs was made, the car being switched from road to road and stopped at any point as the necessities of the case dictated.

One may soon expect private electric railways in parks and grounds for excursions of parties. The private electric railway may yet be a feature of rural entertainment. To light a cigar after dinner and be drawn by unseen subtle force silently through shaded avenues among lakes and trees, stopping or moving at will, would not be an unpleasant experience especially when accompanied by agreeable companionship.

RECALESCENCE in Steel and Iron has been made the subject of investigation by Mr. F. J. Smith with the employment of new methods. The object of the investigations and experiments was to establish the relation of time to the change of form and change of temperature which takes place in this peculiar phenomenon. For the general reader it may be explained that the term "recalescence" is applied to a manifestation of increased temperature which occurs in the cooling of iron or steel at certain temperatures; that is to say, when the cooling has proceeded to a given point, instead of progressing steadily farther, it pauses, and the metal is observed to become temporarily hotter. This manifestation of increased temperature is undoubtedly due to certain molecular changes which occur at these critical temperatures. Without attempting to describe in detail the methods and apparatus by which Mr. Smith obtained his results, it will be sufficient to say that he found the changes of form of the metal under investigation took place synchronously with the change of temperature, and that a curve traced on smoked paper was an indication of the changes of form as well as the changes of temperature. The most peculiar feature however of the result is that by proper appliances certain sounds, evidently of molecular origin are heard at certain temperatures. Upon cooling a wire when a temperature of about 490° C. was reached, a sharp crackling sound was emitted. When the steel wire which emitted these sounds was placed in a magnetic field, the sounds were in no way altered or obstructed by the magnetic action. There is a practical side to experiments of this kind. Ultra-scientific as they may seem, the year at present leading to methods of testing steel which there is reason to believe will be far more efficient than those heretofore available.

The Mortality of Cornish Miners is asserted to be more than double that of the male Cornish population in the aggregate. Out of one hundred different occupations enumerated by Dr. Ogle, the last but four in a list purporting to give the relative healthiness of various callings is the Cornish miner. The cause is stated to be the inhalation of minutely pulverized stone which rises from the drills worked by compressed air, the holes being bored dry. The list refers to the years 1880 to 1882 inclusive. In the address of Prof. C. Le Neve Foster, delivered in June of the present year, at the Royal College of Science, London, he refers to this list as indicating the condition of the health of Cornish miners, in comparison with that of miners in other localities, but seems to imply that an effective change has been made since the time of its compilation; for though he regards this high mortality in Cornwall as a sad blot upon British mining, he states that the next census will probably show an improvement resulting from a general amelioration in the atmosphere in which the men have to work.

Allotropism of metals is beginning to receive the attention its importance demands. For the benefit of the general reader it may be explained that "allotropism" is a term used by chemists to denote the property possessed by some substances of assuming under different treatment or different sets of conditions, without combination with any additional substance, two or more states, each with distinctive properties not possessed by the substance in other states. Among the earliest sub-

stances discovered to exist in allotropic forms was carbon, which in its three states of charcoal, graphite and diamond, presents both physical and chemical characteristics so diverse, that did not ultimate analysis resolve these forms all into one and the same substance they would certainly be classed as different substances. Sulphur and phosphorus, also, assume allotropic forms; and the different states of these substances have found important applications in industry. Now that systematic investigation of this curious property as it relates to metals, particularly steel, has been initiated, the results may prove to be far reaching in their effects upon metallurgic processes. In another place in this number is printed a brief notice of tests of steel, which are understood to be, at least in part, the outcome of such research. Among those who have discerned the possibilities in this line of research prominently ranks Mr. W. C. Roberts Austen. In an article on this subject, *Engineering* (London) calls attention to the fact that as early as 1846, it was shown by Joule and Playfair that metals in different allotropic states possess different atomic volumes; and Matthiessen, in 1860, was led to the view that in certain cases where metals are alloyed they pass into allotropic states, probably the most important generalization which has yet been made in connection with the molecular constitution of alloys. Instances of allotropy in pure metals are: Bolley's lead, which oxidizes readily in air; Schutzenberger's copper; Fritsche' tin, which falls to powder when exposed to exceptionally cold weather; Gore's antimony; Graham's palladium and allotropic nickel. Joule has also proved that when iron is released from its amalgam by distilling away the mercury, the metallic iron takes fire on exposure to air, and is therefore clearly different from ordinary iron.

The Richness of the Quartz Mines in the Republics of Ecuador and Colombia is estimated by a correspondent of the *Scientific American*, Mr. Edwin H. Prindle, to be on the average fifty per cent. more than in mines of California. He thinks, however, that they never will be adequately worked until they are brought under the direction of Yankee brain and capital, and until a railroad is built to get in the proper machinery. This done, he regards it as certain that the Colombian mines will produce 100 per cent. more gold than all of Uncle Sam's dominions.

The Discovery of Gold in France in the Departments of Hautes-Alpes and Isere, near the villages of Grand-Closs, Challanches, Allemont and Traverse on the main route from Grenoble to Briançon, will probably lead to the attempt to separate the gold from the silver, lead, nickel and cobalt ores which have hitherto been worked in these regions. The assays made by the experts indicate that these ores contain about four ounces of gold per ton of mineral. Some of the silver bearing lodes are reported to contain 50 per cent. of metallic lead with assays indicating ten ounces of silver per ton of ore. In other lodes the silver is said to range from 60 to over 150 ounces per ton.

Terrorite is the name of a new high explosive said to be more powerful than high grade dynamite and applicable to blasting, shooting oil wells, and other purposes where a high explosive is desirable. It is claimed that it may be used in any kind of guns without change in the guns or in either the projectiles or fuses. The following are its properties as stated by its manufacturers: It is four to six times as powerful as commercial dynamite. Shock, jars, jolts and other mechanical influences do not affect it. It is smokeless. The direct application of fire does not explode it. It burns steadily until the heat exceeds 260 or 280° C. It is so stable that it does not deteriorate by prolonged storage. It may be made of any consistency from semi-fluid to plastic. In contact with iron, copper, brass, zinc, tin or lead it does not decompose. Its explosive force is not affected by frequent changes of temperature. In precisely how far these claims may have been substantiated we are not in position to judge.

The Closing Down of the Anaconda Mine at Butte City, which took place about the last of April is likely to lead to discoveries. 2500 men were thrown out

of work and a large number of these soon started off prospecting in the mountains. The country around Flat Head Lake is likely to be the prospecting ground for many of these adventurers. It is said that some very fine Galena ore is found in the district. There has been considerable speculation about the causes for the closing down of the mines. The cause originally assigned was conflicts with the railroad over freight rates, but this is not generally accepted as the true one. The largest output of copper in the world has been from the Anaconda and mines associated with it. In 1890 it exceeded 31,000 tons. The gross production of these mines up to the end of the year has been estimated at a value of $25,000,000.

A New Steel Company organized with a capital of $1,000,000 to build large steel works at Ensley City, near Birmingham, Ala., has received a $100,000 subscription to its stock from the Elyton Land Company of Birmingham, and the *Manufacturer's Record* (Balto.), states that $300,000 more will be promptly taken by the Tennessee Coal, Iron and Railroad Company. In an editorial upon this new enterprise, printed in the journal named, it is asserted that these subscriptions assure the placing of all the stock at an early date, and the enterprise is regarded as marking the determination of the leaders in Southern iron interests to push forward into steel making on a large scale. The projector of the company is Mr. T. T. Hillman, long identified with the development of the iron business of Alabama and Tennessee.

Important Results Obtained from Recent Researches of Osmond and others upon recalescence and the physical condition of carbon in steel, led Mr. W. Anderson, C. E., to suggest to the Institution of Mechanical Engineers a systematic research upon this subject. A committee was appointed and Prof. Roberts Austen was commissioned to undertake the work, adequate assistance being provided. Mr. Anderson announced in his paper that a report would shortly be made to the institution named. No explanation of methods anticipating the promised report were given, but he stated the results obtained were such as to warrant his belief "that before long a method will be arrived at by which it will be possible to determine the quality and conditions of masses of steel, from the mere shavings turned off, far more accurately and rapidly than by means of any test which we are able at present to apply." This brief notice of Mr. Anderson's paper indicates its value very inadequately, but from it those interested in the metallurgy of iron and steel will gather that good work upon a very important subject is under way and in a hopeful stage of advancement.

Difficulty in Devising Tests for Steel that, under all conditions, and with steel of different intrinsic qualities will, with reasonable certainty, indicate to the user these qualities, and also the condition of the material with reference to internal stresses, was well set forth by Mr. W. Anderson, D. C. L., M. Inst. C. E. in a paper recently read by him before the Iron and Steel Institute. In this paper he gives reasons for the unreliable character of chemicals tests for steel, notwithstanding for many, perhaps most substances, chemical tests are a safe guide to purchasers. It is the sensitiveness of steel (as regards its physical properties) to the presence of even extremely minute quantities of other substances associated with it, that baffles chemical analysis, not because such analysis is impossible but because the detection and quantitative determination of these often mere traces of foreign substances, are too tedious and expensive to be commercially practicable. The difficulty met by the British Government in framing specifications for steel are exhibited in the following quotation from Mr. Anderson's paper as published in a recent number of *Engineering* (London):

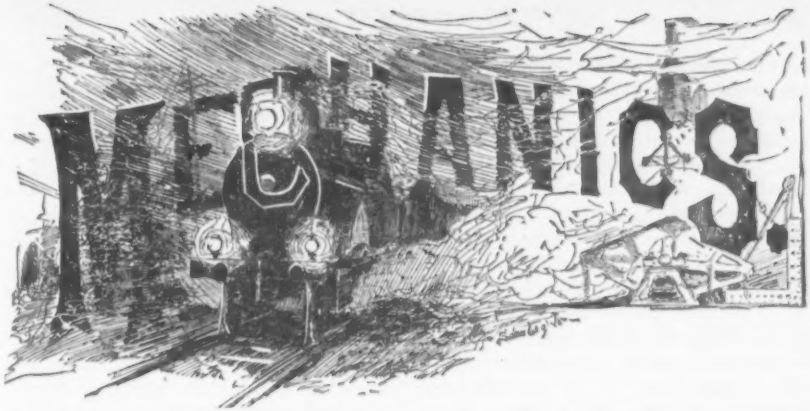
"The specifications of gun-steel used in Her Majesty's service exclude all definitions of chemical composition, in so far, at any rate, as the proportions of the ordinary ingredients of steel, such as carbon, manganese, silicon, phosphorus, and sulphur are concerned. The introduction of new materials, such as chromium, aluminium, or nickel, is indeed, not forbidden, but special care is taken to ascertain their

ffects upon the mechanical properties of the metal before their use is sanctioned. With respect to steel for lighter work, such as small arms, and especially for use in the production of swords and bayonets, some restrictions in chemical composition are imposed. In the former case, however, the percentage of carbon is defined with a view to the hardening which some portions of the components of a rifle have to undergo, and with reference to the durability of the barrels in regard to erosion by powder gases and abrasion by the bullets. In the case of swords, the difficulties of framing a satisfactory specification are so great, that the subject was specially referred to Sir Frederick Bramwell and to Sir Benjamin Baker, and by them the nature of the steel to be used was, indeed, defined by its chemical composition, but with the sole view to secure uniformity in supply, the swordmaker being permitted to vary the components of the steel he proposed to use within certain limits. Once, however, the quality supplied is found suitable by the mechanical tests imposed, the chemical composition so selected is not to be departed from beyond reasonable limits of toleration; and I think that I may venture to affirm that the chemical tests for sword steel were adopted only because it was found impossible to define the qualities required by physical tests alone, seeing that sword blades have to be hardened and tempered, and are therefore subject to internal stresses, the nature and intensity of which certainly depend upon the chemical constituents of the steel, as well as upon the form of the blade and the mode of treatment."

A Busy Life with far reaching results was that of Prof. George N. Mowbray, who died at his residence at North Adams, Mass., on Sunday, June 21st, in his 77th year. The mining and engineering professions are indebted to him for the improvements in the manufacture of nitroglycerine, which first rendered this important explosive successful in its application to blasting. He superintended its use in the construction of the Hoosac Tunnel, and continued its manufacture until nine years ago. His next invention was an insulation for electric wires. For six years past he has been the chemist for the Seylonite concerns at Seylonite. Eight months ago he patented an invention of smokeless powder, and has since been consulting chemist for the Maxim and Nordenfeldt Arms Company of London, who have contracts with all the Continental Governments. His life has been one of ceaseless activity, his experiments being continued until within a few weeks of his death. Prof. Mowbray was a gentleman of the old school, charitable, courteous, and a fine conversationalist.

The Croton Magnetic Iron Mines located at Brewster, N. Y., (W. H. Hoffman, General Manager) after an exhaustive test of several months with various machines for grinding their magnetic iron ore, preparatory to concentrating, decided to adopt the Sturtevant Mill in preference to all others. A second machine has been erected at their present works, and an order placed with the manufacturers for eight more for their new works to be erected this season, which will give a daily grinding capacity of 2500 to 3000 tons. They report that one 20" machine grinds readily 20 gross tons per hour, giving a product granular in form, which is superior for concentration, and making less fines than any other process. The Sturtevant Mill has also been adopted at the Benson Mines, Little River, N. Y. The Orford Copper Co., after running one of these machines several years, (grinding copper matte) have recently put in another to increase their output, which speaks well for its merits. These machines are not only adapted for this class of work, but also for grinding quartz, phosphate rock, cement, limestone and similar material, a large number being in successful operation and endorsed by some of the most prominent manufacturers and mining engineers. The demand is rapidly increasing, and the company reports a large number of recent orders.

A Big Strike in Oil was made in Washington Co., Pa., about the last of May. The oil was struck at a depth of 2200 feet. The yield, large at first, continues encouragingly good.



A COMPOUND Horizontal Engine for the Kaiser-I-Hind Cotton Mills, Bombay, constructed by Messrs. John Musgrave & Sons, Limited, at Bolton, England, and illustrated in *Engineering* (London), is a beautiful piece of mechanism. A construction of fly-wheel and pulley combined has been adopted, which is not often seen in the United States. The fly-wheel is a rope pulley 27 ft. in diameter and grooved for 28 1¾ in. ropes. Its weight is 50½ tons. On the inside of the rim of this pulley, teeth are cast, and into these teeth gears an automatic barring engine, so that there is no difficulty in turning the main engine off its centre. The space between the hub, spokes and rim are filled in with wood, the spokes projecting slightly, giving a very ornamental appearance to the fly wheel. It will, of course, be inferred that the ropes running on the grooved pulley are substitutes for the ordinary large drving belt.

A New Automatic Oil Cup invented by D. M. Perine, of Baltimore, has been introduced by a Pittsburg manufacturer, and has features of merit. One of these features is a sort of leather valve or disc of any fibrous material pressed against a central opening in the middle of the cap of the oil cup by means of an underlying coil spring which is put under compression in screwing down the cap. A pin regulates the feed of the oil to the journals and is so arranged that it acts like a valve, closing whenever the journal ceases its motion, and feeding at a greater or less rate according to the greater or less velocity of the shaft. To supply this cup with oil it is not necessary to unscrew the cap; all that is necessary is to press the nozzle of the oil can against the leather valve, forcing it a little way below the upper part of the cap; then the oil runs readily into the cup. The valve immediately closes the opening when the can is removed and thus prevents any access of dirt or dust into the interior.

The Burning of Lead Joints is an operation which a correspondent of the *American Machinist*, who says he has had some experience, advises to be done by a professional lead burner, as it is an operation entirely aside from the ordinary plumber's business, and the chances are that an inexperienced plumber would make a bad job of it. The writer has also had experience in the employ of plumbers in making burned lead joints, and his opinion is entirely concurrent with that of the correspondent referred to. The burning of lead joints is a very delicate operation to perform well and requires long experience and good judgment. If thin spots are left the acid seems to select these spots for attack and they will soon leak. Of course vessels, pipes, tanks, etc., which are to hold acids must have their joints made by the actual union of the lead. A solder joint will very soon fail. The writer has however, used for the management of sulphuric acid, vessels made of sheet lead in which the joints were united with solder which would withstand the action of strong acid for some days and even weeks, by using a very large quantity of the sol-

der and overflowing the edges of the lead to some distance from the margins with a considerable body of the cementing material. However, for any permanent use such joints would be extremely unsatisfactory.

A Very Ingenious Tube Bending Machine has been recently patented and brought out in Glasgow by an engineering firm. This machine avoids the necessity of filling the tubes with sand or other yielding material while bending, in order to prevent their flattening at the bends. The bending is performed by rollers axially arranged after the manner of rollers for bending sheet metal; but the rollers have their peripheries grooved in such manner that the grooves have exactly the contour of the semi-circumference of the tubes to be bent. This prevents any distortion of the cross-section of the tube, external pressure compelling the circumference to remain exactly as when the tube is passed into the rollers. The tube is drawn along by the rotation of the rollers at a uniform speed. The curvature of the bend is regulated to any desired radius by adjustment of the centres of the three rollers employed, to and from each other, the axes of these rollers being sliding, adjustable blocks. The perfect smoothness and the truth of the bending are said to be admirable and the process is extremely rapid.

A Simple Device for Pressing on Car-wheels, used by Master Mechanic Charles Graham, of the Delaware, Lackawanna and Western Railroad Company, at Scranton, Pa., is described in the *Railway Master Mechanic*. By this device a wheel can be pressed on to exactly the proper gauge position without a shoulder on the axle. Mr. Graham, has the wheel fit and journal turned down to the same size. Then he has a cast-iron block 14¼ in. in diameter and 13¼ in. long, hanging central with the axle and between the axle and the head of the press, and held by a small chain from the longitudinal guy rod of the press. One end of this block has a recess 9 in. in diameter and 1-16 in. deep, the latter dimension being the length that the axle is to project beyond the wheel. The method of using this device will be readily understood, and it will be seen that when it is used it is an easy matter to tell when the wheel is at its proper place by the sudden increase of pressure in the gauge caused by the end of the axle striking against the bottom of the recess in the block.

An Anti-Rust Paint is now manufactured in Manchester, England, for the protection of the bright parts of machinery against rust while handling, transporting or erecting, and it is stated that many of the largest engineering firms in England are now using it in preference to a dope of white lead and tallow. The reasons for this preference are that while the metals are more fully protected than by the ordinary dope, the paint will cover about three times as much surface, and can be very rapidly applied, as it is laid on with an ordinary brush without previous warming. There are no fatty acids in this paint, and therefore it does not become rancid. As an example of the extreme efficiency of protection afforded by the use of this paint, it is stated that a quantity of machinery, having been sunk in the Humber River, remained immersed there for several weeks. Unprotected iron in the water of the Humber corrodes with great rapidity: hence this was a very severe test. When raised, the bright parts, which had been protected by this paint, were entirely untarnished, while the other parts of the machine, which had been covered by ordinary oil paint, were found denuded and badly corroded. The *Ironmonger* states that the use of this paint is becoming extended to the painting of iron bridges and of other immersed or exposed iron work.

The Subject of Apprenticeship is discussed by a writer in a recent number of the *American Machinist*, who advocates a return to the old indenture system as being the only way to secure thorough training of operative mechanics. We think that in his discussion of this subject he overlooks the important changes which have taken place within the present generation in the organization of mechanical labor. The introduction of machine tools has been fatal to the old system of educat-

ing mechanics by a long apprenticeship to do any or all of the operations and functions pertaining to any individual mechanical trade. The use of these labor saving machines evolves a subdivision of labor, which is entirely incompatible with competency to perform all functions. The learning of a trade now consists in the acquiring of the knowledge necessary to effectually operate some particular machine or class of machines. Fifty years ago the use of planers in machine shops or of engine lathes was almost unknown. Metal turning was mostly done by hand and the cold chisel, file and scraper were almost universally used for surfacing. Shapers, screw-cutting machines, radial drilling machines, drop presses and all the paraphernalia of the modern machine shop have nearly supplanted hand labor in the strictest sense of the term, and the classification between bench and vise hands, and mechanics employed for operating machine tools is radical and complete. We do not see how it would be possible to go back to the old system of indenture apprenticeship as suggested by the writer referred to.

A Cement for Steam Pipes and Joints equally good for water pipes either hot or cold, as given by an expert and found by the writer to be excellent in practice (as it withstands not only heat but pressure and is very durable) is herewith placed at the service of our mechanical readers. Take of Paris white and yellow ochre, each 5 pounds; litharge, 10 pounds; red lead, 5 pounds; black oxide of manganese, 4 pounds. The ingredients named together either with or without addition of a little asbestos, are to be mixed into soft putty with boiled linseed oil. In drying, which soon takes place after application, this cement acquires a strength and hardness which meet all requirements.

A Steam-Engine Indicator for indicating engines running at extremely high speed has come to be a desideratum. Prof. Perry recently exhibited at a meeting of the Physical Society in London, a novel form of indicator, which it would seem contains at least the germ of the high speed indicator desired. It consists of an artificially illuminated mirror, to which is imparted two rotary motions, each at right angles with the other, one produced by the means of the piston of the engine and the other by variations in pressure the light reflected from the mirror forming a diagram visible to the eye. The next step would appear to be to permanently record these diagrams by photography, and we have no doubt that in some way by the aid of electricity and photography together, the indicator for high speed engines will be attained.

A Curious Phenomenon with water-gauge glasses for steam boilers has been described in *Industries*, London. It is probably one of the causes for failure not generally understood by users of boilers. The upper end of the gauge glass, where it enters the steam space in the boiler, is sometimes attacked above the packing, being either worn out into ridges and grooves or uniformly reduced in thickness until it is nearly eaten through. When this occurs in a gauge glass of about three-quarters of an inch in diameter, fracture is very likely to occur; when the corrosion extends to about half the thickness of the size of the tube the lower end of the glass immersed in water is not attacked. As evidence that specific action of the steam is not the cause of the corrosion of the upper end, the fact that, at the upper end, the glass is attacked only on the outer surface is cited. No explanation of this selected action has been given. To prevent it as far as possible the upper end of the gauge glass should project from the packing no more than is absolutely necessary.

Aluminum Alloys, of which the exact composition is not stated, are now offered in the market, as superior to even sheet-copper, while the cost is not much above that of tinned iron. They are supplied in continuous sheets or rolls, two feet wide and fifty feet long. Samples of these alloys tested with grease by the writer did not form verdigris like copper, or, at least, did not form it after several days contact. On this account this material seems adapted to grease boxes for journals, screw covers for ointment-pots, pomade boxes and similar vessels.

The Greenland Exploring Expedition under command of Lieut. Peary, which started from New York on the 6th June, is a notable scientific event from the large number of able scientific men who have eagerly volunteered to take part in it. The experiences of unspeakable privation and hardship which have invariably accompanied such expeditions have not daunted these ardent seekers of the unknown. Once the scientific spirit takes full possession of the mind, the ardor of pursuit overcomes all consideration of self-sacrifice; and this is sufficient reason why, so long as any part of this globe remains unknown, there will never be difficulty in enlisting for its exploration a high grade of talent. There is a fascination in penetrating the yet unrevealed secrets of nature to which nothing else is comparable, and the power of which cannot be realized by any who have not personally felt it. This fascination has often led and will continue to lead men into struggles as severe and requiring as much personal courage and strength of will as ever tried the nerves of soldiers in battle. The plan of the present expedition avoids the continual conflict with ice, which has characterized former expeditions, as it is proposed to surmount the great Humboldt Glacier and do the work of exploration on foot with the aid of snow shoes. It is doubtful whether this plan will result in less hardship than has been experienced by former exploring parties; but all will hope that the originality of the scheme and the pluck which is willing to risk untried dangers may be rewarded with success. What shall we say of the brave little woman, accustomed to ease and refinement, yet willing to take her share of whatever fate is in store for this band of scientific adventurers, and who, instead of discouraging and dissuading, brings to her consort her personal co-operation in an undertaking so full of peril, so utterly devoid of what is consonant with feminine taste and comfort? We shall be greatly mistaken if the aid and comfort which such feminine influence will add to this remarkable expedition does not prove the most interesting feature of its yet unwritten narrative.

The Abundance of Clay suitable for Pottery to be found in the South is made the subject of an article in the *Manufacturers' Record* (Balto.). The "Journal" asserts that there exists in the South the foundation of a large and prosperous industry in these vast stores of fine clays, and expresses entire confidence that the "same intelligent and patient enterprise that has developed the iron industry of the South from a merely nominal position into a great potentiality, if applied to the production of pottery wares, would give her eventually the leadership in this branch of manufacture. With more than one-half of this country's supply coming from Europe, with the markets of the Southern American nations open to our products, there are abundant inducements offered to the South to utilize her clays by engaging in this great and profitable industry."

The Threatened Prosecution of M. de Lesseps, on the charge of obtaining money from share-holders by misrepresentation, is a lamentable episode in the sunset of

his long, vigorous and useful life. It is difficult to believe that there is any good foundation for these charges, or that M. de Lesseps has wilfully and intentionally obtained money for his unfortunate scheme by falsehood. Much must be allowed for enthusiasm and self-delusion in his case, wherein a sanguine temperament has probably led him to more hopeful conclusions than the circumstances would warrant. It is hard that the fame of his earlier achievements should now be clouded by even the suspicion of crooked methods. The best wish the admirers of this really great man can entertain for him is that the charges may be judicially passed upon and that he may be able to entirely disprove them.

Caution in the use of Averages was one of the strong points enforced in a paper read by Dr. Venn of Caius College, Cambridge, England, at a meeting of the Royal Statistical Society on the 26th May. The prevalent habit of almost implicit reliance upon common arithmetic means or averages of numbers of magnitudes, in many cases perfectly proper, was shown by him in other cases necessary to be used with revision and care. Comparative results form the bulk of ordinary statistical inquiry, and for purpose of comparison almost any kind of average will answer the purpose, provided the same method is adhered to throughout. Order of arrangement of numbers or groups, the increase or diminution of groups in respect to any characteristic in these groups is scarcely affected by the particular kind of average employed. If, however, accurate quantitative results are desired, the selection of the kind of average must depend upon the precise object in view. A common arithmetic mean may be best and probably in most practical cases is so, but Dr. Venn points out that there are many cases in which some other kind of average becomes not merely more convenient but distinctly more accurate. He cites the well-known class of cases in mensuration where an average is resorted to to discover an actual or metaphorical true value. An instance of a purely metaphorical "true value" is the curve of mortality. He questions whether the resort to a single mean or average in computing this curve is not only unsuitable but actually misleading. When the curve of error is so arranged that the arithmetic means correspond to the most frequent result he holds that the common average loses most of its significance and importance, and that the mere assignment of the average by it may misdirect the attention from some of the most important characteristics of the phenomenon.

Seven Hundred and Fifty Thousand Tons of Household Refuse are annually produced in London, and according to *Engineering* "the vestries are at their wit's ends to know how to dispose of it." To a very interesting article in the journal quoted, descriptive of old, present and prospective methods of dealing with this vast heterogenous mass of material, it devotes three full columns. From this we learn that if ever (as has been the tradition), there were fortunes made in dealing with this refuse, the days of the "golden dustman" are over. *Engineering* asserts that "either the quality of the dust has changed, or the former means of dealing with it have ceased to exist, as now it is a source of expense from first to last, and the object of all concerned in its removal is to get rid of it as rapidly and cheaply as possible. At one time the 'destructor' opened a prospect which was full of hope to the parish officials, and they grasped at the idea of burning up all the foul rubbish, and thus getting rid of it once and for all. But that time has passed. The suggestion of establishing a destructor in a district sets all the inhabitants in arms, and gives rise to an outcry that cannot be resisted. In theory the incineration of refuse is beautiful, and it can be carried out fairly well in practice, so long as the apparatus works under favorable conditions. But somehow a break-down occurs every now and then, and the stink of burning animal refuse pervades the neighborhood. It is very easy to see how this may occur if the fires are allowed to get into bad condition. The collecting vans come in irregularly; sometimes several may arrive together, and if the men tip their damp contents

one after another into the furnaces, there is a great probability of the fires being checked and a volume of smoke given off that does not get completely consumed by the appliances provided for the purpose. Much of the evil may be due to carelessness or want of management, but whatever may be the cause the destructor has earned for itself a bad name with the public, and it is almost impossible to establish one within the precincts of a town."

Much has been said and something has been accomplished in the United States in the line of cremators for garbage, and the experience of London with this method as above recited, may be of value in determining the practicability of burning garbage on a large scale. Our opinion is that the way to dispose of garbage, as distinguished from ashes, is to burn it on the premises where it is produced. In small quantities the difficulties of burning it pertaining to the large "destructors," as they are called in England, do not come in. Once this method becomes recognized as the best, manufacturers of stoves and other heating apparatus will provide convenient means for carrying it out. A difficulty which will have to be met will be that the poorer and unrefined portions of our city populations will attend to sanitary matters with regularity only under systematic supervision and compulsion. A way to overcome this obstacle can probably be found. Some will say, perhaps, that this suggestion is for a return to individualism, and this is admitted, all the more freely, when the writer recalls that, in a city in which he once fortunately resided, the streets were never so clean as when they were required under an efficient police supervision to be kept well swept by the respective individual occupants of the property which they bounded.

Contract Labor Immigration, early gave indications of the troubles to which it has given rise. Forty years ago an experiment in this line was carried out in Connecticut. Two installments of Scotch-English quarrymen were imported in 1852 to work in brownstone quarries. The Boston *Globe*, in a recent article states that "their passage was paid, and they were to work that out the first thing. Those who remember them—the companies had most cause—say they were chiefly single fellows, rough and tough. One workman having a grievance, all stuck by him to the striking point. Bosses of the men upon the rocks were afraid of the gang. One boss held over the edge of a 100-foot face of the quarry until he pleaded for his life, was an example not to be misunderstood. Some of them never worked out their passage at all. Many did settle, however, only to be superseded in time by another race."

The New Odd Fellows' Building in Philadelphia, to be constructed after plans of Messrs. Hazlehurst and Huckle, will occupy the site of the old Horse Bazaar, at the southeast corner of Broad and Cherry streets. Much is expected from these plans when the details are carefully elaborated. The building is to front on Broad Street, with an imposing entrance. In style the design is somewhat ecclesiastical. The front will be of brick and stone. The building, when completed, is expected to be one of the finest structures yet erected for the order of Odd Fellows, rivalling some of the more magnificent and notable Masonic buildings.

Electricity in Mill Work was very exhaustively treated of by Mr. O. S. Hussy in a paper presented at a recent meeting of the New England Cotton Manufacturers' Association. This was carrying the war into Africa with a vengeance, and Mr. Hussy improved his opportunity by explaining very fully the advantages to be derived from the adoption of electric power in mills and large factories. It is only quite recently that the transmission of power to a distance by means of electricity has become a recognized method of obtaining power economically, and mill-owners in many parts of the country are scarcely alive to the fact that if water-power is available anywhere within a radius of a few miles from their plants, that power can be delivered to the mill machinery easily and economically by means of the all-powerful electric current. Electric power can be advantageously utilized in mills and factories in a number

of different ways, such as the following: Isolated motors located in different parts of the building and used to drive lines of shafting and separate machines; tramway systems for handling goods in the mills and between different departments; electric hoisting machinery of all kinds, such as elevators, whip and drum hoists, etc., and electric pumping machinery. The great advantage of electric power installations is the extreme flexibility of the system. Generators can be supplied ranging in capacity from 10 to 3000 horse-power, or more; and the same generator supplies current to a motor of one-eighth horse-power and to a motor of eighty horse-power. The expensive and cumbersome lines of shafting and mazes of belting are done away with and replaced by unobtrusive wires, the saving in room being also very great. Each machine or set of machines can be driven from a separate motor, which is quite independent of all the rest; the motor occupies but little room and can be placed on a shelf if necessary; it has only one moving part, the armature, and consequently requires very little care and attention to keep it in good running order. Electric hoists and elevators are now made ranging from 3 horse-power up to 100 horse-power. In Boston and Brooklyn electric hoists are used for dock purposes with great success. Electric pumps of all sizes have now become a staple article of manufacture. Summing up the advantages of the electrical distribution of power, they may be briefly stated as follows: It permits of the utilization of water-power situated at a distance and which would otherwise be unavailable. In the absence of water-power, electric transmission renders a concentration of the steam plants possible. Small, expensive, and perhaps troublesome steam plants are done away with, and in their place is established a large, well-equipped and economical central station, from which the required amount of power is conveyed with small loss to the different motors wherever placed.

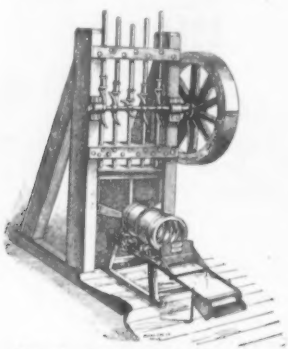
Apropos of Prof. Haupt's Articles on Roads in our May and June numbers, the following opinion of Prof. H. Lunge of Zurich, upon American pavements, given before the Zurich Engineering and Architectural Society, is of interest:

"The pavement of American cities is almost everywhere miserable. In fact, except in the great cities, pavement is wholly lacking in all but the principal streets, and in these it often happens that it comes suddenly and unexpectedly to an end, and from this point no one enjoys the pleasure of walking knee-deep in mud, wherever it is impossible to avail one's self of the plank crossings laid over the street here and there. On looking about during a promenade one sees a multitude of posts, of which it is rare to find one standing vertically. These posts carry electric wires, many of which serve for lighting the streets. Although electricity finds in America greater application than anywhere else in the world, the lighting of the streets is generally very poor. Except in cerrain open squares, and in streets illuminated by brightly lighted stores, the electric street lighting in New York and Philadelphia is no better than the gas lighting in Zurich, which is certainly not saying much for it! An exception is to be found in Chicago, which of all American cities visited by the writer leaves in this respect least to be desired."

"A Farce" is what the New York *Sun* calls the trial of Mr. Chauncey Depew *et al.* for the misdemeanor of heating car-stoves contrary to law, a trial which resulted in their acquittal. "A farcical District Attorney" is what the same paper calls the prosecuting officer. The officers of a corporation cannot vicariously commit a misdemeanor decides Mr. Justice Van Brunt. Good! What then is law itself but a farce? And what in nine cases out of ten are the men who expect to right their wrongs by legal process, but miserable puppets in the hands of the lawyers who make them dance? A very energetic but unpleasant and unprofitable dance they generally find it, that is to say, unprofitable to the puppets. To the lawyers, it is usually otherwise, and one fancies it must be sometimes even amusing. If, as has been said, law and common sense agree, the conflicting decisions, pretexts for delay, the reversals of the decisions of one court by the decisions of another, are inexplicable, except on the supposition that the machinery of law exists for the benefit of lawyers.

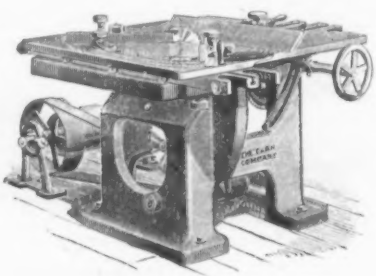
NEW MECHANICAL APPLIANCES.

THE COOK AMALGAMATOR.—Of immense importance to men engaged in the great gold mining industry of this country is the problem of saving the fine float gold carried in suspension in the water from the mills of all free milling gold mines, and large sums have been spent in experimenting in this direction hitherto without success. It has been demonstrated by experiment that fully ten per cent. of the gold found in what is termed "Free Milling Ore" floats in the water and is lost. It has apparently fallen to Dr. Cook, president of the Cook Mining Machinery Co., a mining expert of wide and varied experience among the mines and mills of Colorado, to solve this problem and to introduce to the mining world a machine which he claims saves all the fine float gold that is now carried off in suspension and lost. A subject so important as an improved and economical method of treating free milling ore is sure to arrest the attention of the practical and progressive mill men of the country, and whatever prejudice against new amalgamating devices may still exist, it is bound to be over ridden by the modern progressive spirit which is rapidly displacing old fashioned methods and adding largely to the yearly earnings of some of our best mills. It is claimed for the "Cook Amalgamator," and the claim is endorsed by some of our best mill men, that it does all the amalgamation, and does away with tables, mercury traps, slimers, settlers and all the present amalgamating devices. The following advantages are also claimed for its use with similar endorsements from practical mill men. It does away with battery amalgamation and allows the stamps to drop faster, thus increasing the capacity of the mill. It requires very little attention and is cleaned up much quicker than any present device, consequently the "idle" time of the stamps is greatly reduced.



The Cook Amalgamator.

IMPROVED DOUBLE RIP AND CROSS-CUT SAW.—In the present rapid march of improvement only the best tools and appliances are sought by intelligent well-posted manufacturers. Of this character is an improved double rip and cross-cut saw, with tilting table, manufactured by The Egan Company, one of the most enterprising, and, so far as the designs of its machinery are concerned, one of the most original houses in its line of business.



Double Rip and Cross-Cut Saw.

The saw is designed for general use in edging, ripping and cross-cutting. Its design is well represented in the accompanying cut. It is particularly adapted for pattern-makers, for use in railway shops, and for accurate work of any kind requiring the use of a saw.

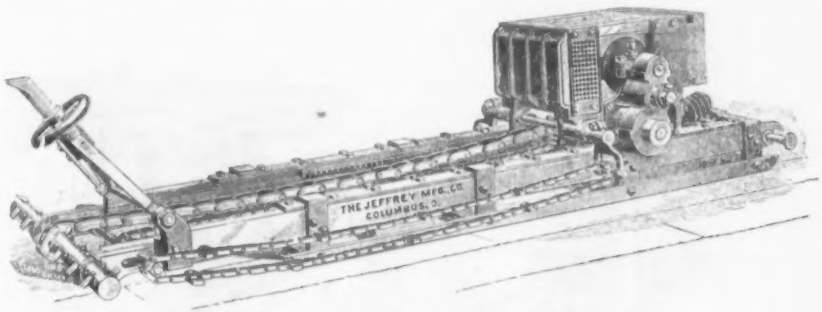
The construction is extremely simple. The adjustments can be changed to suit.

the work desired in a very few minutes. The column or frame is one entire casting. The saw mandrel is arranged to revolve around a common centre inside the column, so that when the ripping saw is above the table, the cut-off saw is below the table. For grooving, either saw can be brought above the table according to the depth of groove to be cut. The table is of iron, in two sections, the one at the left being made to work back and forth on rollers, for edging or cross-cutting. Two mitre fences for cutting right and left, and one ripping fence are all accurately fitted to the table in line with the saw. The mandrels are of the best quality of steel. They run in self-oiling boxes lined with the best genuine Babbitt, and are driven from a countershaft placed clear of the column. This feature is regarded as a decided improvement.

The Egan Company's offices are at 212-232 West Front street, Cincinnati, Ohio.

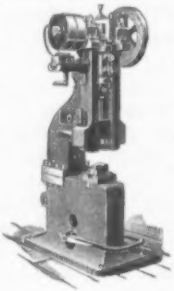
THE JEFFREY ELECTRIC COAL MINING MACHINE.—This machine consists of a bed frame occupying a space 2 feet wide, by 8 feet 6 inches long, composed of two steel channel bars firmly braced, the top plates on each forming racks with their teeth downward, into which the feed wheels of the sliding frame engage. Mounted upon and engaging with this bed frame, is a sliding frame, similarly braced, consisting mainly of two steel bars, upon which are mounted at the rear ends, the Electric Motor, from which power is transmitted through straight gear and worm wheel to the rack, by means of which the sliding frame is fed forward. Upon the front end of this sliding frame is mounted the cutter-bar, held firmly by two solid steel shoes, with suitable brass boxes. The cutter-bar contains bits, made of tool steel, held in place by set screws. When the cutter-bar is revolved, these cutters or bits cover its entire face. The cutter-bar is revolved by an endless curved link steel chain from the driving shaft, and as it is revolved, is advanced by the above mechanism into the coal or other material, to be under-cut to the desired depth.

The Electric Motor occupies a space of about 20 inches square, is built in the most workmanlike manner, both mechanically and electrically. The current required is from 30 to 50 amperes at a pressure of 220 volts; the motor is wound to develop fully 15 H. P., though frequently in some veins of coal the machine only uses 30 amperes or 7½ H. P., in making cuts. The machine is started by means of a switch located on a suitable resistance box, on the rear end of the motor, the same being arranged with buttons; the current is gradually turned on by simply passing the lever over these buttons. The Armature of the motor is calculated to run at a speed of 1000 revolutions per minute, from which the speed is reduced, so as to run the cutter-bar 200 revolutions per minute. The momentum of the armature is such, that ordinary obstructions met by the cutter-bar in the coal are not perceptible, causing the machine to run steadily and comparatively quiet. The general design will commend itself to engineers.



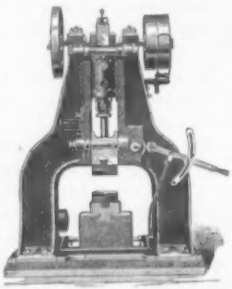
The Jeffrey Electric Coal Mining Machine.

THE HACKNEY HAMMER is new in the class known as pneumatic hammers. It may be explained that hammers of this kind strike their blows through power derived from air which has been compressed in a cylinder by a piston. The air acts when imparting its force precisely like a powerful compressed spring suddenly released, and in fact it is such a spring; hence such hammers are sometimes called air-spring hammers.



From the *American Machinist* we are able to condense a description of this new machine-tool which will, we think, in its general features at once secure the approval of practical mechanics accustomed to power hammer construction and operation.

Two styles or types are shown in the engravings. The first is the single standard hammer designed for comparatively light forging. The second is called the double standard hammer and is suitable for heavy work. The same principles of working are, however, embodied in each.



At the top of the standards there is a forged-steel crank-shaft working in bearings of phosphor bronze, one on each side of the crank. The crank works in a yoke, having a sliding box of phosphor bronze, this yoke being attached directly to the air cylinder below, which is thus given a vertical reciprocating motion in the slides formed in the standards. Within this cylinder is a piston, which, by the usual rod, is attached to the hammer head, the air, more or less of which is confined above and below the piston, serving to transmit motion to it and to cushion it at the end of each stroke. It is almost as though a sentient muscle under full control were interposed between the crank and the hammer head.

The admission and confinement of air in the cylinder is controlled by four valves, which may be worked by hand or foot, as is most convenient; two being merely admission valves, which automatically admit air to supply the place of what may be lost by leakage, so that any reasonable amount of leakage does not interfere with the working of the hammer, and the piston and stuffing-box need not be so tight as to interfere with free working. The valves at the back of the cylinder by which the motion of the hammer is controlled, are opened and closed by means of a sliding wedge, operated by a system of levers. They open in reverse directions, so that when one of them is opened by the wedge the other is closed.

By this arrangement air may not only be confined above the piston but also below it, thus holding the piston between two air springs each of which opposes the action of the other, and this opposition is regulated at the will of the operator, so that it may be increased till the force of the blow is reduced to nothing, or diminished so that the full force of the hammer is realized; and this may be done instantly so that the very first blow delivered may have no more force than necessary to crack a walnut, or may have the full force of the head impelled at high velocity upon the piece to be forged, the intensity of the blow depending upon the position of the valves.

Provision is made for arresting the hammer instantly at the upper end of the stroke, and this may be done after the delivery of a single blow by a brake controlled by the same lever that operates the valves, so that every drop forging can be and is being done satisfactorily under the hammer without any special preparation. This feature greatly widens the range of work which can be performed, as compared with ordinary power-hammers.

The guides are adjustable for wear, and may be easily replaced. Six sizes from 50 to 500 pounds are made at Cleveland, Ohio, by the Hackney Hammer Company.

EDITOR'S EXCHANGE TABLE.

ILLUSTRATED articles are indicated by an asterisk (*), continued articles by a dagger (†), and concluded articles by a double dagger (‡). Orders for copies of the publications mentioned should be sent direct to the addresses given.

JOURNAL OF THE FRANKLIN INSTITUTE. *m.* 50c. Philadelphia. JUNE. "The Progress of Chemical Theory:—Its Helps and Hindrances." *Dr. Persifer Frazer.*‡ "Possibilities of Applied Science." *Oberlin Smith.* "New Alloys and their Engineering Applications."* *F. Linwood Garrison.* "On the Ammonia Process of Water Analysis." *Reuben Haines.* "Analysis of Artesian Well Water." *Reuben Haines.* "Supplement to the Determination of the Heat of Evaporation, etc., of Liquid Ammonia." *Dr. Hans Von Strombeck.* "On the Heat of the Formation of Fluorides." *Jas. W. Richards.* "The Diazotype Process of Photographic Dyeing and Printing." *John Carbutt.* "A Rough and Ready Dynamometer for Small Motors." *John Haskin.*

ELECTRIC RAILWAY ADVERTISER. *bi-m.* Boston. JUNE 1. "The Atkinson Gas Engine."* "The Simplex: A Motor on a New Principle."* "The Portelectric Transportation System."* JUNE 15. "Railway Train Lighting." *William Langdon.* "Engines for Electric Railway Stations."*† "Power for Street Car Traction." "Electrical Traction." *Sydney F. Walker.*

THE STREET RAILWAY JOURNAL. *m.* 35c. New York. JUNE. "Cleveland City Cable Railway."* "The St. Louis Railroad Co.'s Cable Plant."* "Trans-Electric, Cable, Horse and Other.—How to Build, Maintain, and Operate Them." *C. B. Fairchild.*† "How Good Street Railway Service Helps a Community. *H. M. Whitney.* "How to Reduce Operating Expenses on Cable Railways.—Practical Suggestions from an Operator's Standpoint." *M. K. Brown, C. E.* "Electric Mine Haulage." *H. B. Prindle.* "The Gearless Motor." *Edward E. Higgins.**

THE SOCIAL ECONOMIST. *m.* 20c. New York. MAY. "Machinery and Culture." "Economics of American Shipping,"—*Capt. Wm. W. Bates, U. S. Commissioner of Navigation.* "Future Location of Cotton Industries." "History of Eight Hours in Australia." "Wages as a Criterion of Civilization."

THE RAILWAY REVIEW. *w.* $4 per year. Chicago. MAY 23. "Street Railway Track." *T. C. Gribble C. E.* "The Permanent Effect of Strain in Metals." *Prof. R. H. Thurston.** MAY 30. "The Application of the Postal Principle to Railway Traffic." *James L. Cowles.* "Heating, Forging and Tempering Metals by Electricity." "The Field Feed-Water Heater and Purifier."* JUNE 6. "A plea for Piece-Work in Railway Shops." "Process of Water Softening on the Midland Railway." "Grain Weighing and Transfer Car."* JUNE 20. "Purification of Water for the Use of Locomotives in France."* "The Power of Congress with Respect to Common Carriers."

THE ELECTRICAL ENGINEER. *w.* 3d. London. MAY 22. "Electric Traction—Underground Lines."† "The Electric Lighting of Public Buildings With Special Reference to the Athenæum Electric Light Installation." *Prof. Jamieson, M. I. C. E., F. R. S. E.* "Researches in Electro-Magnetic Induction." *E. B. Vignoles.**† MAY 29. "The Electric Tramway at Budapest." *F. Uppenborn.* Trans. from *Elektrotechnische Zeitschrift.* "Researches in Electro Magnetic Induction." *E. B. Vignoles.**‡ MAY 29. "On the Most Economical Way of Feeding a Low-Pressure Network." *R. E. Crompton.* JUNE 5. "Electrical Storage Batteries." *H. B. Vorley, A. I. E. E.* "The Waddell-Entz Alkaline Storage Battery System." "Electrical Storage Batteries." *H. B. Vorley.**†

ENGINEERING. *w.* 6d. London. MAY 22. "The Transandine Railway Tunnelling Plant."* "Hydraulic and Electric Transmission of Power." *Robert Gordon Blaine, Finsbury Technical College.* "Schuckert Dynamos at the Frankfort Exhibition."* "Otis Elevators on the North Hudson County Railway, N. J. U. S. A."* "Petroleum as the Future Fuel of the Pacific Coast." "The Internal Stresses in Steel Plating Due to Water Pressure." *Mr. J. H. Yates, M. Inst. Naval Architects.** "The Columbian Exposition of 1893."* "Stationary Engineering Practice in America." *James B.*

*Stanwood.**† "London Societies"—The Royal Society.† "The Lahmeyer Current Transformer."* "The Mellinite Disclosures." "A Standard of Color." "The Visp-Zermatt Adhesion and Rock Railway." MAY 29. (Not received.) JUNE 5. "Fifty Ton Fairbank Steam Crane."* "Hydraulic and Electrical Transmission of Power." *Robert Gordon Blaine.*‡ "The Otis Elevator at the Frankfort Exhibition."* "The St. Louis Merchants' Bridge."* "Stern-Wheel Gunboat for the Russian Service."* "An International Engineering Congress." "The Rupture of Steel by Longitudinal Stress." "Compound Controlling Appliances for Multiple Cylinder Engines."*

ENGINEERING NEWS. *w.* 12c. New York. MAY 30. "Notes on the Nicaragua Canal."*† "The Present Outlook for Manufactured Fuel-Gas." *Geo. H. Christian, Jr.* "High Unbraced Wrought Iron Columns."* "Mountain Railway Construction." JUNE 6. "The American Railway Viaduct—Its Origin and Evolution."*† *J. E. Grenier, C. E.* "The Brooklyn Water Works Extension."*† "Wooden Water Mains."—*A. McL. Hawks.* "Methods of Working and Surveying the Mines of the Longdale Iron Co., Va." *Guy R. Johnson.** "Railway Construction in the South." "Contraction of Area of Cross-Section as an Index of Quality in Tests of Iron and Steel." "Manganese Steel."* *Henry M. Howe.* "The Underground Transit Route." "Proposed New Water Supply for Birmingham, England."*

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